Annual Railway Issue

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Engineering News-Record

Elimination of Grade Crossings by Highway Relocation, by M. W. Torkelson

Arthur's Pass Tunnel in New Zealand Complete, by F. W. Fuckert

Progress on the Moffat Tunnel Through the Rockies

Railway Valuation, by William D. Pence — Status of Automatic Train Control

Roadbed Drainage on Chicago Terminal Lines of the Illinois Central

Airplane View of Horseshoe Curve On the Pennsylvania R.R. Near Altoona Pa.

And

A dozen shorter articles, including ***Job and Office*** hints

Also:

Typhoid Epidemic in Santa Ana, Calif., Caused by Drain Sewer Connection

Staff News Report on American Concrete Institute Convention

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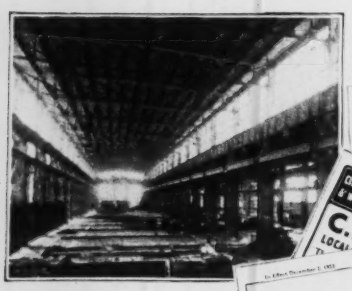

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FRANK C. WIGHT
Editor

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Let's Wait Awhile

IN ALL the hysteria that is afflicting Washington just now—and some of it is justified if ever hysteria is justified—it is just as well for citizens to remember that the primary question in the case has not been settled. Were the government oil-leases illegal or not? There has been much talk about and around that question but so far there has been no proof one way or the other. Let the Senatorial fishermen cast their lines over whatever likely pool they please. They may hook a fish that will go down for years as a record breaker. But while they are engaged in these fishing expeditions in streams far removed from the original brook, don't let us forget where the first fish was caught. To drop the metaphor, let us wait the result of the Pomerene and Roberts action on the oil leases before we become too excited about the degeneracy of modern government.

Capitalizing An Anniversary

TAKING advantage of the twentieth anniversary of its founding the American Concrete Institute staged something out of the ordinary in technical meetings at the annual convention last week. One whole day was devoted to a review, by specialists, of the various phases of development in the use of this primary structural material. Such a meeting had possibilities of infinite dullness but it can be truly said that it was far from that. The arrangements for the meeting had been so carefully made, the program was carried out in such orderly fashion and the speakers covered their subjects in so concise and interesting a fashion, that the three hundred odd in attendance stayed through both sessions, totaling nearly six hours, with a faithfulness not always evident in technical meetings. The Institute and its speakers are to be congratulated. It is a pity that more engineers and concrete users could not have been present, for even to one who has followed fairly carefully the progress in the concrete art, the completeness of the story told was informing. To those who have not kept abreast of concrete's development or to those who wish in short compass to get an airview photograph, as it were, of that development, an hour or so reading of the papers when they finally become available is recommended.

Education for the Practical Man

ONE other feature of the Concrete Institute meeting is worth commending; that is the "question box" session for concrete superintendents. The literature of concrete is large and growing. Somewhere in print can be found an answer to almost every question regarding concrete that can be put by a reasonable and inquiring mind, and if every one immediately responsible for the placing of concrete understood and practiced the teachings of all of this literature we would be through with all but a few of our disturbing problems in concrete construction. Unfortunately this wide distribution of knowledge is not even approximated and nowhere is personal experience more frequently made superior to group experience than among the foremen and superintendents upon whom finally rests the responsibility for good concrete. It is a fault of the practical man to overvalue his own experience and to depreciate the knowledge and experience of others. In concrete, because of the fact that behavior of the finished structure is so hard to predict from its appearance while under construction, this emphasis of personal knowledge has elements of danger. To neutralize this danger, education is necessary and no better education is possible than such symposium discussion as the one the Institute staged last week. The pity is that so few could attend. There is a field here for the local engineering society or section for one of its regular meetings.

A Definition of Concrete

SOME discussion is being aroused in the American Concrete Institute because of the definition of concrete which was adopted anew last year as a report of the Committee on Nomenclature. That definition reads as follows: "Concrete—A compound of gravel, broken rock or other aggregates bound together by means of hydraulic cement, coal tar, asphaltum, or other cementing materials. Generally (always in the specifications of the American Concrete Institute), when a qualifying term is not used, portland cement concrete is understood." Complaint has been made that concrete today should only be used to denote portland cement concrete and that no general definition permitting anything else to be termed concrete should become a standard, with its possibilities of reference in dispute or lawsuit. Inasmuch as technical journals in general and this journal in particular are quoted in the discussion we may be pardoned a brief statement of our views. Concrete, in the general acceptance of the construction industry, is the artificial stone formed by the hydration of a hydraulic cement around a matrix of inert aggregate. Of course portland cement is the predominant hydraulic cement but there are others, such as natural and alumina, which have the same general hydraulic properties and they will indubitably make concrete. There is no justification that we can see for confining the definition of concrete to the portland cement variety. As for the non-hydraulic binders, usage has long connected them with concrete, though of late years with the adjective prefix. There is, therefore, ample justification for the Institute's definition, provided it is remembered that we use the prefix "bitumen" or "asphaltic" before the "concrete" when those binders are used and that plain and unadorned "concrete" has a hydraulic cement binder. Whether that binder is portland, natural, alumina or some more complicated variety is a matter of specification and not definition.

How Far in Automatic Train Control?

AUTOMATIC train control has a popular appeal. Anything which promises to overcome the inevitable human frailty which, in spite of all precautions, results every so often in railway collisions, offers a fertile field for promotion, and so certain a reward, if successful, that it is no wonder that inventors for years have been busy on the problem. More than that, as is common in the history of all inventions when so many separated individuals work on the same problem, their endeavors have actually resulted, if not in success, at least in sufficient promise of success to make desirable a more extended and more expensive field experimentation.

This in itself is sufficient explanation for the first Interstate Commerce Commission order for the installation of 49 experimental divisions of automatic train control; but if it were not sufficient, it might be recalled that railroads are naturally conservative about radical measures of this sort, especially in such times of financial stress as existed just subsequent to the war. They are furthermore becoming more and more reluctant to take the initiative in any measure which has by law come within the province of the Interstate Commerce Commission to order. So it happens that the continuance of government direction in safety matters has taken away from the railroads much of that early independence and initiative which brought about, for instance, the block signal system and the air brake.

Having this reluctance to start anything new in mind, the Interstate Commerce Commission was quite justified in its 1922 order for experimental automatic train control installations. Whether their later order increasing these numbers from 49 to 141 is equally justified is a fair matter of doubt. To be sure, the railroads have accepted the early order with resentment and have proceeded to carry it out with a slowness which casts considerable doubt upon the possibility of full experimental installations being made in the period required. Apparently, then, the commission, disgruntled because the railroads have been so slow in complying with its first order, has issued the second order as a reprimand for tardiness. Unless some better reason than has been put forth so far is offered by the commission for the increase of installation that later order would certainly seem to be ill advised.

The first order, if properly carried out, would have provided all that was needed for the present time at a minimum of expense—one whole division on each of the 49 principal railroads of the country, where a system of train control could be studied under actual conditions, in order to learn its defects before ordering another installation. The commission itself in its first order recognized that the discovery and elimination of undesirable features would be an inevitable development of the art. Yet in the face of this statement it has now doubled the number of divisions to be equipped with train control before the railroads have completed the first installation.

The result of this precipitate action may be that some of the devices now on the market will not be tried because the railway companies, faced with the cost of installations extending over two or more divisions, will choose some device that can show results from practical tests, rather than one which has possibilities but can show no proof.

It is difficult to see why the railroads, once a number of them have one division equipped with train control, should not be given ample time to stud[y] [in]stallations. With one exception, none of [t]hese has been given extensive service tests and all [m]ust need to be studied and developed in order [t]o bring them up to a state of perfection in [w]hich they will give an amount of safety commensurate [w]ith the dependence that will have to be placed upon [t]hem or else to eliminate some of them entirely.

It is freely admitted that the railways [h]ave not been as active in the prosecution of these studies as the demands of the situation seem to call for, but surely the Interstate Commerce Commission could have found some other way to prod them into action than to increase the amount of experimental work demanded. It is not more experiments that are required; it is an immediate carrying out of the early experiments and a quick study of the operation of such devices as are now available.

Another Inexcusable Typhoid Outbreak

THE Santa Ana typhoid epidemic has lessons for water-works and health officials the length and breadth of the country. It shows, first of all, how a potential source of water infection may escape notice for years and then suddenly lay hundreds of victims low with typhoid, many in death. At Santa Ana, as appears from the article elsewhere in this issue, the overflow from a deep well was connected by a short drain with a sewer lateral in an abandoned street. Some one should have foreseen the possibility that sewage might back up from the main sewer through the lateral, then through the drain and down into the well, but if any did foresee this no one acted upon it.

The Santa Ana epidemic shows how essential it is that both local and state authorities search for such lurking menaces at sufficiently frequent intervals. The need is all the greater where deep well supplies are drawn from because it is so generally assumed that artesian waters are safe and so infrequently recognized that while the water itself may be pure the well head or well casing or a pump pit may be subject to infection by surface or near-surface pollution. In fact, a large percent of the typhoid outbreaks for some years past have been caused by either this sort of pollution or else such cross-connections between city and railway industrial supplies as caused the Fort Wayne outbreak commented on in this column last week.

How frequently the water supply of Santa Ana was subjected to bacterial tests we do not know. Only by chance would the tests come at a time when a heavy rain backed up the sewage and it may be that for years there was no such backing up. Be all this as it may, it appears that Santa Ana was not without occasional warning of danger, for it is stated that less serious outbreaks of water-borne diseases had preceded the one now drawing to its close. Why was not the cause run down? Presumably because this community of some 20,000 people lacked one or all of three things a place of even smaller size should have had and used to avert typhoid disasters: (1) Vital statistics that clearly showed unduly high water-borne diseases; (2) a competent full-time health officer to recognize that these figures were high and find the cause; and (3) a water-works superintendent or manager with his eyes ever on the vital statistics to detect the slightest implication that the water-supply was a menace to health and life

and with his mind and all other forces at his command active to detect and remove sources of pollution.

Santa Ana is on a much traveled highway. This recent infection was carried from Santa Ana as far east as St. Louis and on into Illinois. In these days of travel, no place lives unto itself alone. Municipal negligence, be it in traffic or in typhoid control, may prostrate people from distant states or countries.

Crossing Elimination by Relocation

WHAT portion of the cost of highway relocation undertaken to divert traffic from a grade crossing can be assessed against a railroad is one of the vexing questions facing many state highway officials. The railroads, generally, have opposed paying a large part of the cost of highway crossing elimination work when such elimination was obtained by the simple means of grade separation. This opposition has resulted, in many states, in laws specifying what per cent of the cost shall be borne by the railroad, county or municipality, and the state. But when elimination is to be accomplished by a relocation of a highway, thus doing away with the crossing entirely or reducing it to a minor crossing serving only a few farms, then there are few precedents for proportioning the cost of the work. As the idea of eliminating crossings by this means is gaining in favor, Wisconsin's experience in apportioning the cost will be of value to highway officials in other states.

It is to be hoped that decisions such as that rendered by the Wisconsin Supreme Court will show many railroad officials the needlessness of continuing to kick against the pricks. Railroad grade crossings on heavily traveled highways must and will be eliminated and obviously the cost must be borne by some one. To argue that the railroad company is not concerned in the matter when highway relocation is the solution and therefore should not be called upon to bear part of the expense is just as absurd as to argue that the railroad company should bear all the cost. Both the highway and the railroad are traffic channels necessary to the welfare of the country and should bear their share of the cost. No matter how the crossing is eliminated, whether by separation or relocation, the railroad gains by not having to maintain the crossing or to protect it; and, if, as in the Wisconsin case, the railroad's share of relocation cost is computed by capitalizing the annual charge for protecting the crossing, then the cost to a railroad for relocation will be much less than for grade separation in most cases.

Lack of funds for crossing elimination is one of the railroad arguments against undertaking the work, but if the railroads would only realize that once a community makes up its mind to eliminate a dangerous grade crossing, the crossing will be eliminated sooner or later, then co-operation on the part of the railroad might lead to entire elimination of the crossing at considerable less cost to it than for an overhead or undercrossing forced upon it after extended and costly litigation.

Many states are planning for a program of grade-crossing elimination based on a study of present needs and the needs when new highways are constructed. Comparatively little can be done where new highways have already been built other than to decide upon the order of preference in elimination, but where new highways are planned such co-operation between railroad and state highway officials will tend to prevent needless expense in highway grade-crossing elimination.

Railroad Valuation

FEDERAL railroad valuation, now ten years old, goes back in its origin something like twenty-five years, to the state valuations carried out in the days just preceding the establishment of public utility regulation. So few persons today remember clearly the causes and early events of the important movement that a sketch survey of its development has been drafted by W. D. Pence, from close personal knowledge. It is particularly enlightening and thought-provoking as a sketch not of the work done but of motives and movements.

The heavy public burden of all of this valuation work must justify itself by its returns, which have not yet been realized. Proportionate to the huge cost, the intricacy of the problems involved in valuation is great. The technical difficulties, formidable as they were, have been fairly well overcome. On the other hand, the legal and policy complications remain troublesome, and, as may be seen today in partial retrospect, they are more serious than the engineering questions. But they, too, appear to be on the way toward adjustment.

Valuation began to be demanded soon after the close of the big railroad-building era and a short experience with open competition just afterward, ending in the breakdown of the competitive principle. Reorganization, combination and regulation were the inevitable answers to this breakdown. With them came violent differences of view, the antagonism between the bourbon spirit of the mid-period of the railroads, and the countervailing radical spirit. But two decades have tended to clarify and harmonize thought. The opposing views have steadily approached one another and today are nearer agreement. Both sides now base their practical thinking on the view that private enterprise and public interest are partners in rail transportation. Even judicial interpretation has taken some cognizance of this view and in consequence is tending toward a stable middle position between its earlier swings from one side to the other.

What place valuation will finally take in the adjustment of the railroad-and-public relation is still to be determined. In part, no doubt, it depends on the further growth of judicial study; in part, perhaps, on clearer public thinking and on legislation. Statute law has already established the principle that in an over-all sense the railroad value is to be the basis for returns and rates. So far it has avoided defining details, as, whether value is to have full meaning in each individual case, or how real value is related to physical valuation. The public mind meantime is receiving much education on values of transportation machines in other ways; it has learned that a Ford car has a definite value and knows the factors which determine that value. In time it may take the view that railroads have similar definite values. This growth of thought should help in settling the disputed questions of valuation and earning power.

Even apart from rate or tax questions, the results of federal valuation are substantial and permanent, as Mr. Pence indicates. The data which it furnishes are necessary elements of the records on which proper administration of a railroad system must base. Once the valuation is completed, the costly process of attempting to determine cost many years after completion will never again need to be undertaken, and railroads will not have to go through the disconcerting experience of becoming acquainted anew with their own property. Not all of the cost of valuation is a debit against rate making.

Automatic Train-Control—Its Development and Status

Description of Types of Automatic Apparatus to Stop Trains or to Lower Speed Being Installed by Railroads Under Current Order of the Interstate Commerce Commission

THE IDEA of using some automatic system to control the operation of trains in case of the failure or inability of the enginemen to do so is not a new one, but a series of accidents and recent orders of the Interstate Commerce Commission have suddenly brought automatic train-control from the state of being a much discussed but little tried theory to one of the practical questions of the day in all railroad circles. Less than two years ago the Interstate Commerce Commission, after extended hearings, decided that the time had come for it to act in the matter, and so issued an order, No. 13413, dated June 13, 1922, which required that 49 railroads install a system of automatic "train-stop or train-control" devices on at least one full passenger-locomotive division, the installation to be complete by Jan. 1, 1925. Up until the time of this order there had been few sections of any railroad, except subways and elevated railroads, equipped with such devices, and these were, with one exception, very short sections of track. The one exception was on a double-track division of the Chicago & Eastern Ill., 105 miles long, completed in 1914.

The Interstate Commerce Commission has ordered all the principal railroads of the country immediately to commence to install on at least one full passenger-locomotive division a system of automatic train-control whereby the train when entering an occupied block or other dangerous zone is brought to a stop or reduced in speed without the interposition of the engineman. This article gives the history of the order and describes the several devices which are being tried out to satisfy it.

Many railroad officials considered that the order was premature, feeling that the art of automatic train-control was not far enough advanced to warrant any such extensive installation. Most of them, however, began negotiations with the makers of the more practical devices of the many on the market, and some who had already made extensive studies let contracts and started the installations. But by Jan. 1, 1924, only one road had completed the installation and received the official approval of the Interstate Commerce Commission, and so, following a number of accidents which it was generally conceded would have been prevented by a successful form of automatic train-control, the Interstate Commerce Commission issued a second order, dated Jan. 14, 1924, in which it directed all but two of the railroads affected in the previous order to install automatic train-control on additional divisions and directed 45 other roads to install such devices on one division. The two excepted roads have but one division.

This order specified that the carriers shall file with the commission, on or before May 1, 1924, complete plans of the signal system in use on the designated portion of line and report the number of engines engaged in road service thereon. It requires that the installations be completed by Feb. 1, 1926. The order was largely unexpected by the railroads, and in view of the amount of work and the magnitude of the expenditure involved it is doubtful whether it can be complied with within the specified time.

History—The history of automatic train-control goes back to a patent issued in 1859 but probably the first actual application was that of a device patented by the late F. E. Kinsman in 1881 and installed on a branch of the Fitchburg R.R. (now part of the Boston & Maine R.R.) at Ayer Junction, Mass. This device became the basis of the permanent installation on the Boston Elevated Ry. in 1899 and of some test installations on other railways. In 1888 A. S. Vogt of the Pennsylvania R.R. devised an automatic stop so arranged that when the wayside signal arm was in the stop position it would be in the path of a glass tube projecting above the roof of the locomotive cab where it would break the tube and apply the air brakes. Soon after the device was installed a tube on a passenger train was broken by an icicle hanging from the roof of a tunnel, bringing the train to a stop in the tunnel and endangering the lives of the passengers. The device was abandoned after this accident. The installation on the Boston Elevated was followed by permanent installations on the interborough Rapid Transit and the Hudson & Manhattan tubes at New York in 1908, the Washington Water Power Co., an interurban electric line, the New York tunnels of the Pennsylvania and of the Key Route at Oakland, Calif., in 1911, and on the Brooklyn Rapid Transit in 1912. These installations were all of the simplest form of train-control—a mechanical trip which opened an air cock and applied the brakes. It is a type that is suitable for such protected locations as rapid transit lines where there is little danger of the trip or the receiving arm being damaged or tampered with.

Fundamental Requirements—The chief function of any automatic train-control device should be to bring a train under control as it approaches an occupied or dangerous section of track and to bring it to a stop before it enters the section. But in doing this it should not interfere with the engineman as long as he responds to the signal indications correctly. If so arranged it serves as a check upon him and increases his vigilance. If not so arranged it makes impossible those niceties of train-control which come from manual operation and results in much rough handling of trains with the consequent damage to equipment and discomfort of passengers.

This amount of control is a fundamental requirement but there are other features of value that can be combined with it to improve the service. One is an auxiliary speed control and the other a system of cab signals to keep the engineman advised of the condition of the track ahead of him. This latter feature is not so important on lines where automatic signals are already in existence but is absolutely essential where there are no track-side signals and where the amount of manual control outlined above is to be maintained.

In order to be of real value any train-control device should conform to certain other requirements. In the first place it should be rugged enough to stand the shocks of railway service. In addition it should conform as nearly as possible to existing clearance limits

avoid the necessity of changing existing structures. It should not introduce dangerous obstructions or increase the hazards of operation by interfering with the operation of existing signal systems. And, finally, its operation should not reduce the safe capacity of the line where it is installed.

Interstate Commerce Commission's Requirements—The Interstate Commerce Commission, in its order of June 13, 1922, specified the following as a basis for all installations:

Purpose—The purpose of this general specification is to define automatic train-stop or train-control devices and to outline essential features involved in their design, construction, and installation on railroads.

Definition of Automatic Devices—A system or an installation so arranged that its operation will automatically result in either one or the other or both of the following conditions:

First: Automatic train-stop, the application of the brakes until the train has been brought to a stop.

Second: Automatic speed-control, the application of the brakes when the speed of the train exceeds a prescribed rate and continued until the speed has been reduced to a predetermined and prescribed rate.

Functions—In prevailing practice the primary function of automatic train-stop or train-control devices is to enforce obedience to the indications of fixed signals; but the feasible operation of essentially similar devices used without working wayside signals may be regarded as a possibility. The following features may be included, separately or in combination, in automatic train-stop or train-control systems:

1. Automatic train-stop, without manual control by the engineman, requiring the train to be stopped, after which the apparatus may be restored to normal condition manually and the train permitted to proceed.

2. Automatic train-control or speed-control: (a) Automatic stop, after which a train may proceed under low-speed restriction until the apparatus is automatically restored to normal or clear condition by reason of the removal of the condition which caused the stop operation. (b) Low-speed restriction, automatic-brake application under control of the engineman who may, if alert, forestall application at a stop-indication point or when entering a danger zone and proceed under the prescribed speed limit, until the apparatus is automatically restored to normal or clear condition by reason of the removal of the condition which caused the low-speed restriction. (c) Medium-speed restriction, requiring the speed of a train to be below a prescribed rate when passing a caution signal or when approaching a stop signal or a danger zone in order to forestall an automatic-brake application. (d) Maximum-speed restriction, providing for an automatic-brake application if the prescribed maximum speed limit is exceeded at any point.

General Requirements—1. An automatic train-stop device shall be effective when the signal admitting the train to the block indicates stop, and so far as possible when that signal fails to indicate existing danger conditions.

2. An automatic train-control or speed-control device shall be effective when the train is not being properly controlled by the engineman.

3. An automatic train-stop, train-control, or speed-control device shall be operative at braking distance from the stop-signal location if signals are not overlapped, or at the stop-signal location if an adequate overlap is provided.

Design and Construction—1. The automatic train-stop or train-control device shall meet the conditions set forth under general requirements applicable to each installation.

2. The apparatus shall be so constructed as to operate in connection with a system of fixed block or interlocking signals, if conditions so require, and so interconnected with the fixed-signal system as to perform its intended function (a) in event of failure of the engineman to obey the signal indications; and (b) so far as possible, when the signal fails to indicate a condition requiring brake application.

3. The apparatus shall be so constructed that it will, so far as possible, perform its intended function if an essential part fails or is removed, or a break, cross, or ground occurs in electric circuits, or in case of a failure of energy.

4. The apparatus shall be so constructed as to make indications of the fixed signal depend, so far as possible, upon the operation of the track element of the train-control device.

5. The apparatus shall be so constructed that proper operative relation between the parts along the roadway and the parts on the train will be assured under all conditions of speed, weather, wear, oscillation, and shock.

6. The apparatus shall be so constructed as to prevent the release of the brakes after automatic application until the train has been brought to a stop, or its speed has been reduced to a predetermined rate, or the obstruction or other condition that caused the brake application has been removed.

7. The train apparatus shall be so constructed that, when operated, it will make an application of the brakes sufficient to stop the train or control its speed.

8. The apparatus shall be so constructed as not to interfere with the application of the brakes by the engineman's brake valve or to impair the efficiency of the air-brake system.

9. The apparatus shall be so constructed that it may be applied so as to be operative when the engine is running forward or backward.

10. The apparatus shall be so constructed that when two or more engines are coupled together, or a pushing or helping engine is used, it can be made operative only on the engine from which the brakes are controlled.

11. The apparatus shall be so constructed that it will operate under all weather conditions which permit train movements.

12. The apparatus shall be so constructed as to conform to established clearance for equipment and structures.

13. The apparatus shall be so constructed and installed that it will not constitute a source of danger to trainmen, other employees, or passengers.

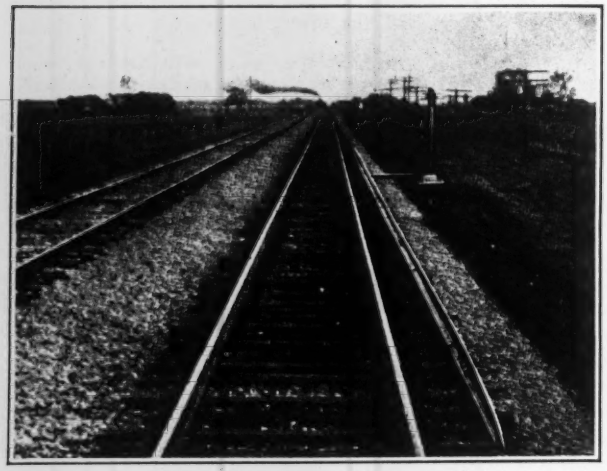
14. The apparatus shall be so constructed, installed, and maintained as to be safe and suitable for service. The quality of materials and workmanship shall conform to this requirement.

Principal Types—Since the time of the granting of the first patent in 1859 subsequent patents have been issued for about 5,000 train-control devices and the Bureau of Safety has examined plans for some 400 complete systems. The great majority of these systems were so impractical that they never got beyond the patent stage and only 28 were presented at the Interstate Commerce Commission hearing in 1922. These 28 included practically all of the systems considered to be designed on correct principles and worthy of further study. They may be grouped in two general divisions—intermittent and continuous, and into subdivisions of contact and non-contact.

Intermittent Control—The intermittent control system depends on signals transmitted to the locomotive at stated intervals either by direct contact with an arm or ramp placed at stated intervals along the track, by magnetic or inductive impulses from elements set in the roadway at or below rail level, or by electrical impulses received from short insulated sections of rail.

Of the direct contact types the simplest form, that operated by a mechanical trip, has already been mentioned in discussing the early installations on subways and elevated railways. It is simple and effective *when operative* but is inherently wrong in principle because the failure of the trip to operate through damage to it or to the whole signal system will not result in stopping the trains passing the damaged signal. This is the feature of automatic train-control which has given railway men much concern; it is but a repetition of the experience with automatic block-signals which resulted in the adoption of the "normal-danger" signal.

Other disadvantages lie in the difficulty of making a mechanical trip which will operate under high-speed conditions and yet not be set off by some light foreign object projecting beyond the clearance line. On subways or elevated railways the trip may be located either near the ground or overhead without this complication but anywhere outside of such restricted locations the above objection applies to trips located near rail level



TRACK RAMP, INTERMITTENT CONTACT TYPE CONTROL

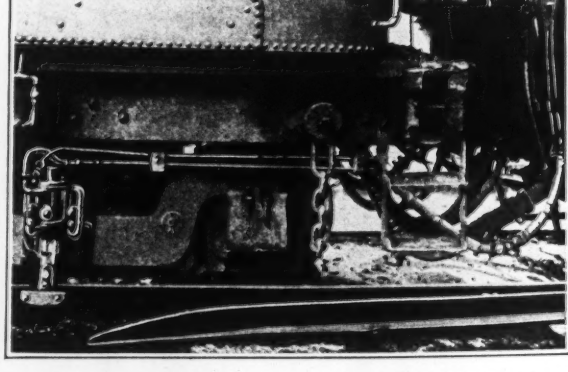
while an overhead trip is practically out of the question on account of the various heights of loads on open freight cars and the danger of train and enginemen being struck in passing the tripping arm at the fixed signal.

Notwithstanding the objections to the mechanical trip systems of control some are being made for general railway service and are being tested out. One of these is an attempt to transmit two distinct impulses to the locomotive valve by an ingenious track device in which the trip has a different position for stop and for caution thus rotating the receiving arm on the locomotive through a large or small arc.

The ramp type of train-control has been developed more generally and at present has the longest record of continuous and satisfactory service. The ramp consists of a short section of rail, usually supported on the ends of the ties and at an elevation of a few inches above the running rails. A shoe on the locomotive tender makes contact with this ramp in passing up and over it and transmits an electrical impulse to an electrically or pneumatically controlled valve on the locomotive. Where automatic wayside signals are already installed the control system operates in conjunction with them and the ramps are located within braking distance of each signal so that either the engineman or the automatic control can stop the train before passing the signal. The usual method of operation is as follows: If the block ahead of the train is unoccupied the ramp is energized and the energy which is received by the shoe offsets the action of the shoe in raising to pass over the ramp, a clear signal is given on the cab signal, if one is used, and the air brake is not affected. If, however, the wayside signal indicates caution the same electrical impulse which set this signal at caution causes a different electrical impulse to be transmitted to the locomotive from the ramp, the cab signal indicates caution and a partial application of the brake is made, reducing the speed of the train. At the same time the speed-control device on the locomotive, when used, is set to maintain the reduced rate of speed until a clear indication is received at a following ramp. With most types of control the engineman can anticipate this action of the automatic valve if he is on the alert and makes the reduction himself before reaching the ramp. In this case the control valve makes no application of the brake but does set the speed-control valve for the reduced rate. If the block ahead is occupied or the signal system is out of order the ramp has no electrical energy and the raising of the shoe on the ramp applies the brake and stops the train.

A number of the train-control devices, until recently, were provided with a manual release whereby the engineman could prevent the train-control valve from operating. This feature was introduced on the theory that in many cases, such as climbing steep grades, the operation of the train-control device would cause unnecessary delay to the traffic; that as long as the engineman was alert to the fact that he was close to the train ahead he should be allowed to control his train. The Interstate Commerce Commission, however, considered that the judgment of the engineer would thus "be the determining factor in situations of known or unknown danger, a factor of human judgment which the automatic stop is designed to eliminate." It, therefore, required that this feature be omitted but approved of an arrangement whereby the engineman can restore the apparatus to normal after the train has stopped.

There are numerous modifications of the ramp system but the general principles are the same. The use of any form of ramp is objected to by many railway men on the ground that ice or snow will interfere with the operation and that the ramp can be damaged or dislodged by dragging parts of cars or by snow plows. Such a system has, however, been in operation on the



LOCOMOTIVE VALVE AND SHOE, INTERMITTENT CONTACT TYPE CONTROL

105 miles of the Chicago & Eastern Illinois R.R. for twelve years under severe climatic conditions without serious trouble.

Intermittent Non-contact—Systems of intermittent non-contact control depend for their operation upon magnetic impulses transmitted from a roadway element set in the track, either between the rails or just outside the rails, to a receiving valve suspended below the locomotive in such a position that it will pass close

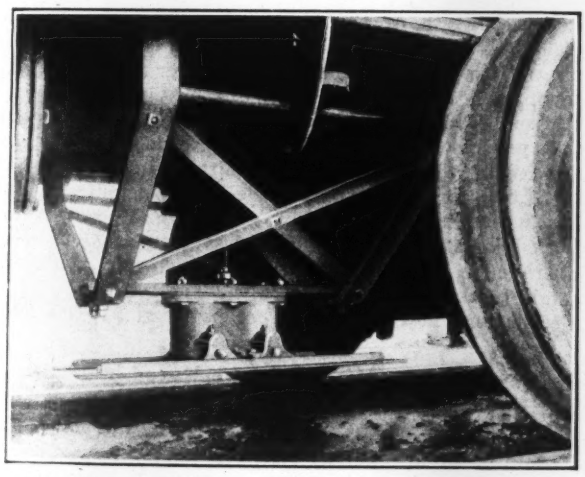
to the roadway element. The roadway element is usually made up of a permanent magnet and neutralizing coils and is located in the same relation to the wayside signals as the ramps previously mentioned. The locomotive valve consists essentially of ports in the air-brake line held closed by magnets of opposite polarity to those of the roadway element. As each train passes over the neutralizing coils of the roadway element they are supplied with current by means of short insulated sections of rail in which the train completes the circuit. This current is passed through relays in the wayside signal system. If the block ahead is clear the current flows through the coils and neutralizes the permanent magnets so that they do not act on the locomotive receiving valve. But if the block ahead is occupied or the block signal system is out of order then the neutralizing coils are not energized and the track magnets act on the locomotive valve opening the air ports and applying the brakes.

Speed restrictions can be provided for by the installation of an additional track circuit of one more rail length together with a slow pick-up relay which restricts the speed at which the train may pass over a specified length of track. No change in the locomotive valve is necessary.

This is the simplest type; other types with more complicated valves on the locomotives and more roadway elements provide for much more flexible control of the train.

Still another type of intermittent control transmits the signal indication to the train by means of short insulated circuits in the track rails. Satisfactory results have not been obtained with this type.

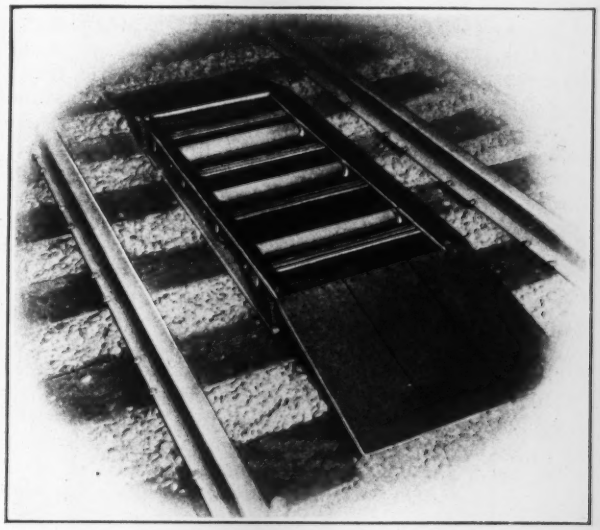
The fundamental disadvantage of any form of intermittent control is that the indication received at the entrance of one block is effective until the next ramp or track element is reached regardless of the changes in conditions which may have taken place in the meantime. This feature tends to slow up traffic and so



LOCOMOTIVE VALVE, INTERMITTENT NON-CONTACT TRAIN CONTROL

reduce the capacity of the railroad but there is little possibility of its becoming a source of danger for with short blocks and the interconnection between the ramps or track elements and the wayside signals which results in the display of stop indications by both if either is damaged or displaced, there is little danger of a train getting a false clear indication; yet there is this possibility and to offset it several forms of continuous control have been evolved.

Continuous Control—Types of continuous control can be classified in the same way as the types of intermittent control, namely as contact and non-contact.



TRACK ELEMENT, INTERMITTENT NON-CONTACT TYPE
Cover and one side removed.

Contact types depend on either a third rail or a trolley wire for transmitting the signal indications to the train. Neither form is considered satisfactory because of the special clearances required (a particularly difficult problem on electrically operated lines) and on account of the difficulty of maintaining continuous contact. Obviously the system must be arranged so that whenever the contact is broken the air brakes will be applied on the train, but under normal operating conditions, particularly when running at high speed, such breaks in the contact are bound to occur with results which, so far, have never been overcome.

The more satisfactory forms of continuous control, known as the continuous induction types, transmit the signal indications to the locomotive by means of an alternating current supplied to the track rails. This current induces current in a collecting apparatus on the locomotive which in turn produces a clear indication on the cab signal and in the train control valve as long as it continues to flow, but if it is interrupted by a break in the rails, an open switch, or a short circuit caused by another train in the block, then a danger indication is given on the cab signal and the train control valve operates to stop the train. Modifications of the system provide for caution signals and speed-control.

The great advantage of the system is that the engineman always knows the condition of the track ahead and does not have to depend on intermittent signals. The disadvantages are that the apparatus on the locomotives must be much more sensitive than with the intermittent control systems, and the installation of the system requires considerable modification of the automatic wayside signal system.

Where continuous train control is installed outside

of territory having automatic wayside signals this latter objection does not hold, and although no such installations have been made, as far as we know, the Interstate Commerce Commission has considered the possibility of such an arrangement and has worded its order so that such installations can be made.

Another form of continuous control which has received some attention is that of transmitting signal indications to trains by means of wireless impulses. So far no satisfactory results have been obtained.

Speed-Control—The use of a system of automatic speed-control in connection with the automatic train-control is not essential from the standpoint of safety, but is desirable in order to keep the train-control from reducing the capacity of the line on which it is installed. If no system of speed-control is used the requirements for absolute safety would necessitate stopping each train upon its reaching an occupied block, but with speed-control it is possible to reduce and control the speed of the train between the caution and stop signals and then to make a further reduction of the speed at the stop signal to a maximum of not over four miles an hour so that the train can enter the occupied block and close up on the standing train at a safe speed. Such a feature is particularly desirable on congested lines. With intermittent control a train upon receiving any indication at one ramp must proceed to the next ramp or track element before the speed can be changed, but with continuous control the speed can be increased as soon as the portion of the block ahead is cleared because the control device on the locomotive receives the indication immediately and releases the air-brake.

Speed-control devices also provide for a maximum speed as a protection against reckless running. Speed around dangerous curves can be controlled by the use of intermediate ramps on territory with intermittent control and by the use of superimposed currents where continuous control is installed.

The usual type of speed-control device depends for its action on a centrifugal governor on the locomotive, but some types have been developed which depend for their action upon the length of time required for the train to go a certain distance.

Present Installations—When in 1920 the Interstate Commerce Commission sent out its questionnaire pertaining to the actual operation of automatic train-stop or train-control devices, 11 roads replied. Seven of these were municipal rapid transit lines and electric lines previously mentioned and one was the Pennsylvania R.R. installation at the tunnels in New York. The other three installations were: 105 miles, double track, on the Chicago and Eastern Illinois, completely installed in 1914; 21 miles, single track, on the Chesapeake & Ohio, installed in 1917-18; and 22 miles, double track, on the Chicago, Rock Island & Pacific, installed in 1920. These three installations are of the intermittent control, ramp type, operated in connection with automatic wayside signals. The Rock Island installation has since been increased to 165 miles of double track and was approved by the Interstate Commerce Commission on Dec. 17, 1923, the first approval of installations made under its order of June 13, 1922. The earlier installation of the Chicago & Eastern Illinois has not been approved because all the engines operating over the division have not been equipped with the control devices, and because the engines, as originally equipped, have certain of the [illegible]missive features of which the commission does [illegible]pprove. Exclusive of the Rock Island installati[illegible] *Railway Age* in its summary for the year 192[illegible]ts 35.6 miles of intermittent non-contact type, [illegible].5 miles of intermittent contact type, and 5.2 miles of continuous induction type as having been completed in 1923, and 218 miles of continuous non-contact type and 62.8 miles of intermittent non-contact type as under construction at the end of the year.

There is one permanent installation of the intermittent non-contact type on the Michigan Central through the Detroit tunnels which has been in operation for twelve years. In addition there are many other short installations for test purposes which are not included in the published lists because of their temporary nature. The most notable of these, and one which will probably be retained permanently is a 52-mile installation of the continuous non-contact type on the Pennsylvania R.R. put in service last July.

Although too early to predict what types will be used generally in complying with the Interstate Commerce Commission's order the present indications are that the continuous non-contact types are receiving preference in the contracts which are now being let.

Results—The installation on the Chicago & Eastern Illinois is the only trunk line installation that has been in service long enough to give an indication of what may be expected in the way of satisfactory operation. Officials of the road and inspectors from the Interstate Commerce Commission are well pleased with the results. The commission's report upon this installation states that out of a total of 659,875 operations of train-control devices there were only 356 failures, of which 15 were false clear indications and 341 were stops. It was largely upon the basis of these tests that the commission decided that it should take some aggressive action to obtain more installations of automatic train-control.

Cost of Installation—The cost of installing depends on the type used, the number of engines to be equipped, and the length of the block necessary to handle the traffic without serious delay. Consequently cost cannot with any accuracy be stated on a per mile basis. The commission's report estimates the cost per locomotive at from $375 to $3,000 depending on the type, and the cost per block, assuming one indication per block, at from $200 to $2,000 for intermittent and from $300 to $1,000 for continuous. The cost per mile on the Chicago & Eastern Illinois is given as $451, and on the Rock Island, a more complicated system, as $702. The Chesapeake & Ohio figures, with two-way traffic on single track, are $1,505 per mile. The total cost of the installations now ordered is estimated at $200,000,000.

Record Amount of Freight Moved in 1923

According to the reports of the Bureau of Railway Economics, the railroad traffic of the country in 1923 amounted to 457,589,846,000 net ton-miles, exceeding by 21.7 per cent the traffic for 1922 and by 2.3 per cent the traffic for 1920. A new high record was also made in 1923 in the average daily movement of freight cars, the average for the year being 27.8 mi. per day, or 1.7 mi. in excess of the best previous average, which was in 1917. The average load per freight car in 1923 amounted to 27.9 tons, an increase of 1 ton over 1922 but a decrease of 1.4 tons under the 1920 figure.

Arthur's Pass Tunnel in New Zealand Completed

Tunnel 5.3 Miles Long to Connect East and West Coasts of South Island, New Zealand—3½-ft. Gage—Single Track

By F. W. Furkert
Engineer-in-Chief, New Zealand Public Works Department, Wellington, N. Z.

THIS TUNNEL just completed and added to the railway system of New Zealand is the last link in a connection between the railways of the east and west coasts of the South Island. In the South Island the great obstacle to railway communication between the fertile plains of Canterbury, with its port Lyttelton on the east coast, and the timber and coal lands of Westland on the west, is the range known as the Southern Alps, which run approximately parallel to the long axis of the island from end to end, 500 miles. The range has many peaks over 10,000 ft., culminating in Mt. Cook, 12,349 ft. high. It has few passes and only one under 3,000 ft., and that is not situated where it can be made use of under the present distribution of population.

After exhaustive surveys, the pass known as Arthur's Pass was selected for railway connection. It has been used for road purposes since 1865, having been discovered in 1864 by Arthur Dudley Dobson. Originally it was thought to build a 6.66 per cent grade (Fell Central Rail System) over the pass, and plans for this were made by the Midland Railway Co. Owing to the backbone ridge being much nearer the west than the east coast, the ordinary grades up to 2 per cent did not rise nearly as high on the western side as on the other, and any summit tunnel would have had to be on a steep grade.

The Midland Railway Co. having failed, the government took up the work and a committee of government engineers decided that the pass should be negotiated by a tunnel 6¼ miles long on a 2.7 per cent grade. Virgil Gay Bogue, the eminent American engineer, was asked to report on the whole project. He recommended using 3 per cent grade and carrying the line along the hillsides to save nearly half the summit tunnel. Detail surveys disclosed such difficult work that another solution utilizing 3.03 per cent grade and a tunnel 5 miles 27 chains long was worked out by the New Zealand engineers and approved by Mr. Bogue.

The character of the country is shown by Fig. 1. Avalanches sweep the hillsides and make open work impossible.

The tunnel rises from an elevation of 1,585 ft. above sea level to an elevation of 2,435 ft. in a distance of 28,062 ft. or a little over 5.3 miles. It is a single track structure 15 ft. 6 in. from rail level to the crown of the arch and has a maximum width of 15 ft. The excavation work was well described by W. H. Gavin in *Engineering News*, May 9, 1912, p. 870. The rock was generally hard, sometimes very hard, alternating slate and greywacke, but timbering was required throughout. The rock generally carried a great deal of water, reaching a maximum flow of 3,000 Imperial gallons per minute, but now reduced to about 1,500 gal. The best progress in driving the tunnel was 13½ ft. per day for 12 consecutive days, but during the whole period the work was undermanned because it required more skilled men than were obtainable in New Zealand during the war. The driving and lining were completed in August, 1921. The lining is of concrete, the arch being formed of precast voussoirs.

Owing to the steep grade, electrification was decided on. Various sources of power were investigated, and the choice fell on steam, though eventually it is probable that the state hydro-electric lines will pass near the power house, when motor generators will be installed and the steam be used only as stand-by.

The generating plant consists of three Babcock & Wilcox marine type water tube boilers, two steam turbines of the horizontal impulse type, rated at 1,600 kw. with a 50 per cent overload capacity, two d.c. generators, 1,650 volts, 1,200 kw. normal rating, but capable of giving 25 per cent overload for two hours, 50 per cent for 30 minutes, 100 per cent for 5 minutes, with 94 per cent efficiency.

FIG. 1—WESTERN PORTAL OF ARTHUR'S PASS TUNNEL
Showing Arthur's Pass and, only faintly outlined in the view, the stage road winding up the Pass.

The overhead work in the open is of the double catenary type as used on the London, Brighton, and South Coast Ry. In the Otira station yard the catenary wires are of steel, but on the main lines they are of copper. In the tunnel a single catenary system is used, supported every 60 ft.

The tunnel is lighted throughout, there being two low

tension circuits supplying 60-watt lamps in bulkhead fittings every 165 ft., so arranged that there is a lamp every 82½ ft. One circuit burns continuously while the other is switched on when required. There are also flood sockets for attaching flexible cords with cluster lights for use of repair gangs.

The locomotives, five in number, are of the 0-4-4-0 type, weighing approximately 50 tons or 12½ tons per axle. The use of one type reduces the number of spare parts and simplifies operation, maintenance and overhaul. One locomotive will be used for passenger trains and two for freight. The contract loads are 280 long tons for freight trains at 15.35 m.p.h. and for passenger 138 tons at 17.35 m.p.h. uphill and 24.8 m.p.h. downhill.

The various uses to which the condensing water is put on its way to the power house are of interest. It is

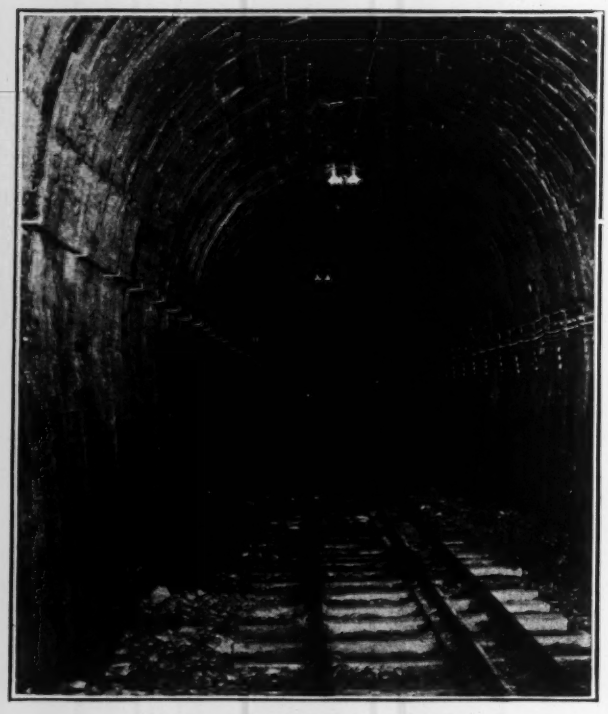


FIG. 2—INTERIOR OF TUNNEL
Showing the mass concrete sides and concrete block roof. The white spot in the center is light from the eastern portal, 5.3 miles away.

drawn from Goat Creek, 625 ft. above the power house, through an intake protected from avalanche by a grillage of old rails. It then passes through a pipe which is concreted into a trench in the rock until it is beyond the region of floods and slides, and then through gravel traps and filter chambers. Then by 10-in. and 12-in. welded steel pipe to a point 520 ft. below, where it passes through a Pelton wheel driving a 125-kva., 2,200-volt generator, which operates in parallel with a similar steam-driven machine in the power house. This hydro-electric set will normally provide all current for lighting, thus making it unnecessary to have the power house staff on duty at night and Sundays when there are no train movements. The waste from the Pelton wheel flows into a circular concrete tank of 78,000 imp. gallon capacity. Then it is carried in 10-in. diameter pipes to drive the air extraction pump with a head of 90 ft. The surplus runs on into a concrete reservoir of 380,000 imp. gallon capacity, placed 25 ft. above the

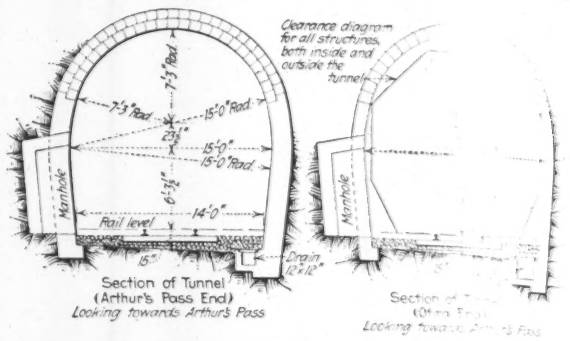


FIG. 3—TYPICAL SECTIONS, SHOWING METHOD OF LINING

power house, whence by 18-in. riveted pipe it is carried to the main surface condensers. The low flow of Goat Creek in winter and the large demand for condenser water necessitated this arrangement of reservoirs, which fill up between trains. The same source supplies domestic water to the railway employees' village, which, besides its water supply, has a septic tank sewage system and electric light.

Railroad Expenditures Pass Billion Mark

THE MOST optimistic predictions in regard to improvements in the condition of the railroads that were expected to take place during 1923 have been far surpassed by the actual results. Improvements in facilities, new construction, new equipment and large economies in operation all made records that were quite beyond anything that had been anticipated when the year opened. New track construction alone amounted to nearly 1,200 miles or more than twice the amount in 1922. Over 400 miles of this was in new single-track lines into new territory. The remainder was in second and multiple tracks. Figures for the mileage of new construction do not, however, give an adequate measure of the improvements, for the expenditures for additional tracks were by no means the largest expenditure for improvements during the year as is shown by the following figures from the Bureau of Railway Economics.

Additions and Improvements 1923

Locomotives	$212,200,000
Freight cars	415,900,000
Passenger cars	49,800,000
Other rolling stock and floating equipment	12,900,000
Additional tracks	116,200,000
Heavier rail	27,100,000
Additional ballast	10,000,000
Shops and engine houses	48,800,000
All other improvements	182,900,000
Total capital expenditures	$1,075,800,000
Maintenance-of-way and structures	821,400,000
Maintenance of equipment	1,474,900,000
Total maintenance expenditure	$2,296,300,000

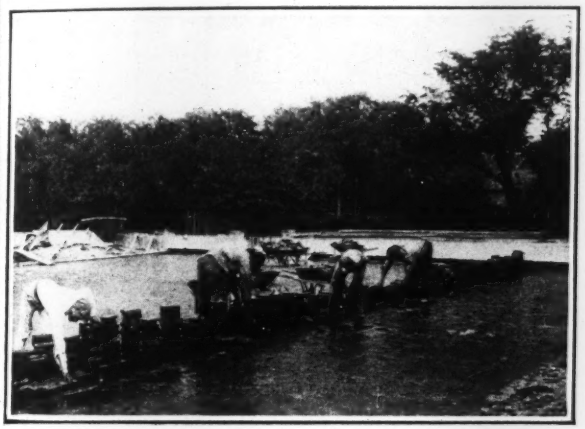
These figures cover the expenditures of the Class 1 railroads, the railroads having an annual operating revenue of $1,000,000 or over. The total mileage of these roads is 235,000 and comprises 90 per cent of the total mileage of the country. The figures are made up from the actual expenditure for the months of January to October and estimated for the remaining months of the year.

Asphalt Blocks Make Satisfactory Protection for Waterproofing

Lackawanna R.R. Uses Asphalt Blocks in Preference to Concrete or Mastic—Can Be Laid Quickly—Give Better Results

By M. Hirschthal
Concrete Engineer, Delaware, Lackawanna & Western R.R., Hoboken, N. J.

In connection with the design of reinforced-concrete structures, particularly viaducts, the details of the utmost importance are the provisions for expansion and waterproofing. If concrete is adopted because of its low maintenance cost and the waterproofing turns out to be defective or the expansion provisions inadequate the results defeat the object in selecting concrete because constant inspection is required and considerable expenditure is necessary for maintenance arising from the dangerous conditions following leaks. Such conditions may even affect the permanence of the construction despite the boast of "Concrete for Permanence." For these reasons particular attention has been given to the subject of waterproofing and expansion in connection with the design of Lackawanna structures.



WATERPROOF MEMBRANE AND ASPHALT BLOCK PROTECTION, D., L. & W. VIADUCT, EAST ORANGE, N. J.

The type of expansion joint uniformly used for concrete viaducts requiring it has frequently been described and illustrated, in connection with descriptions of the various viaducts, both of the arch and flat type, constructed by the Lackawanna R.R. in its various improvements; most recently in an article on the East Orange improvements published in *Engineering News-Record*, March 29, 1923, p. 568.

In the selection of the type of waterproofing for railroad structures two factors enter into the consideration: First, the waterproofing proper, and second, its protective coat, which is designed to protect the waterproofing from being pierced by the sharp ballast and thus having its effectiveness destroyed.

It is evident that integral waterproofing is ineffective for structures of any length that would be appreciably affected by expansion. This eliminates it from consideration for long bridges and viaducts. After experimentation and research extending over a number of years the type of waterproofing selected by the Lackawanna R.R. is that of a membrane consisting of two plies of asphalt-saturated cotton fabric of open mesh laid in hot asphalt and covered with a final mopping of asphalt. This has given very satisfactory results thus far and is the standard type now used.

For the protective coat, three types have been employed: (1) a concrete slab two inches thick; (2) two thicknesses of ¾ in. each of asphalt mastic; (3) asphalt paving blocks 1¼ in. thick laid in asphalt.

The concrete slab has not been wholly satisfactory because so thin a slab develops cracks due to shrinkage and temperature stresses. These cracks fill up with water draining through the ballast and are developed by frost until the concrete layer is broken up and the ballast is permitted to work its way down and pierce the waterproofing. Therefore concrete is no longer used under ballast as a protective coat on Lackawanna R.R. bridges.

Asphalt mastic consisting of an intimate mixture of asphalt, limestone dust, sand and gravel is far superior to concrete as a protective coat and in itself is a waterproof safeguard which when subject to traffic is elastic and at the same time capable of withstanding considerable pressure such as is developed by locomotive and train loads. Its disadvantages, however, are the difficulty of obtaining a continuously uniform mix by field work, particularly on account of the scarcity of mechanical mixing equipment; the handicap of the necessity of an early start on each working day in the preparation of the heating kettles; the danger of burning batches and the loss of time and material entailed; the space required for the equipment, and the time for laying, screeding, and setting before track construction can be started. This last consideration is most potent, leading to the use of the third type described below. Moreover, when not subject to traffic and exposed as in the case of a four-track bridge with only three tracks installed, the mastic appears to lose its life and cracks, while when subject to the summer sun's rays it softens and will not stand on vertical or steeply inclined surfaces.

The third type of protection, the one which has given the greatest satisfaction thus far, consists of a special size asphalt paving block 1¼ in. thick, laid in asphalt. The composition of the block is very similar to that of the asphalt mastic previously used, both as to constituent materials and their proportioning. The blocks have the advantage of being molded under great pressure, greatly increasing their bearing capacity. Moreover, the blocks do not soften under exposure to the summer sun to anywhere near the extent that mastic poured in place does. The mechanical mixing of the materials for the blocks and the devices for timing, etc., ensure a more uniform product than is possible in a field-poured mastic. But the greatest advantage is in the time required to lay the blocks which is a fraction of that required for the mixing, placing and screeding of the mastic in the field, and when laid permits of the installation of the track construction almost immediately after completion.

The process of laying the blocks is very simple. They may be laid on a cushion of sand or in asphalt. On the bridges of the Lackawanna R.R. the blocks were laid in asphalt with close joints which were flushed with asphalt as an additional precaution.

The accompanying photograph shows these asphalt paving blocks being laid on the concrete viaduct from Munn Ave. to Arlington Ave. at East Orange, N. J.

Michigan Central Niagara Bridge Abutments Completed

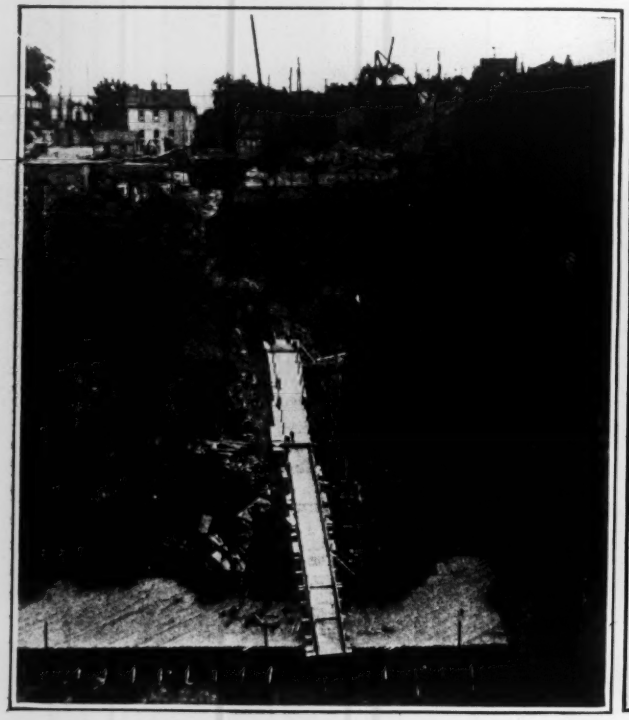
Excavation and Concreting of Abutments and Piers on American Side of Gorge Done in Six Months

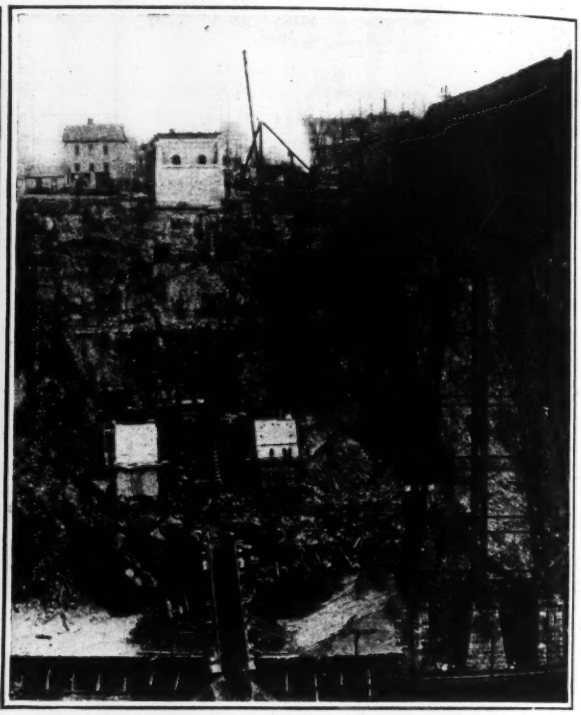
IN LITTLE over six months' time the substructure work for the new bridge of the Michigan Central R.R. across the Niagara Gorge at Niagara Falls, N. Y., has been completed. The structure will be a steel spandrel-braced arch of 640-ft. span, as described in *Engineering News-Record* of March 1, 1923, p. 380. Four heavy concrete blocks constructed at the edge of the principal hard rock stratum at the sides of the gorge form its foundation. The beginning of work on the American side and the appearance of the completed abutments are shown in Figs. 1 and 2, herewith. The last operation, setting the granite coping, is represented in Fig. 3.

Contracts for the substructure work were let on a basis of cost plus sliding-scale profit, because the nature of the work made it desirable to keep full control of the execution in the hands of the railroad company. The Gass-Thurston Co., of Detroit, and the Federal Construction Co., of Toronto, took the contracts for the American and the Canadian work, respectively. Work was actively in progress by the beginning of June, contracts having been let on May 7, and thereafter it was carried on generally with both night and day shifts. Delay was caused by right-of-way difficulties and by the necessity of storing material at some distance from the site. Further delay occurred because, after the rock on top of the bluff had been cleared off preparatory to removing the overhanging rock at the rim, cracks and fissures were found farther back than expected, particularly on the American side, so that a great deal of rock had to be removed. Abutment excavation could not be carried on safely while this was in progress. The work was done with the aid of staging carried up so as to furnish support for the debris and prevent material falling down the cliff. On the American side the Niagara Gorge railroad track made this protection particularly necessary. On this side, also, the extra removal of rock increased the length of the approach span from 100 ft. to 125 ft., and required the anchor tunnels to be carried much deeper than anticipated.

Excavation and concreting for the abutments went on rapidly after the work above was completed, and the stone copings were set in December, this part of the work being done under a separate contract by the Arthur McMullen Co. of New York.

An unforeseen amount of water was encountered in the inclined anchor tunnels, in which the girders and chains for the erection backstays are now being placed. Water came in at the rate of about 40 gal. per minute, and pumps had to be kept going continually. After much trouble it was possible to confine the flow to a few pipes, leading to a sump at the bottom, whence it is pumped. With this arrangement it will be possible to place the concrete without interference by water after the girders and eyebars are erected. This steel is now being placed.





FIGS. 1 AND 2—ABUTMENT CONSTRUCTION, NIAGARA GORGE ARCH OF MICHIGAN CENTRAL R.R.; AMERICAN SIDE

View at left, June 27, 1923, shows staging at rim of gorge for safe removal of overhanging ledge, and shelter shed over Gorge R.R. tracks at foot of cliff.

View at right, Dec. 12, shows completed abutments. Tunnels near top of cliff are to receive erection anchors. Approach viaduct nearly completed.

FIG. 3—SETTING GRANITE COPING, SOUTH PIER

James H. Curtin is resident engineer for the railroad on this work. H. Ibsen is special bridge engineer and J. F. Deimling chief engineer of the Michigan Central R.R. Olaf Hoff is consulting engineer for the bridge.

Severe Water Hammer Causes Break of Big Creek No. 8 Penstock

TECHNICAL study by the Southern California Edison Co. engineers of the penstock break which occurred at the company's Big Creek No. 8 hydroelectric plant on Jan. 1 (reported in *Engineering News-Record*, Jan. 10, p. 92) has developed the fact that the accident was due to an unprecedented combination of circumstances. As the details of the happening are of general importance to hydraulic engineers, the company has made them available for publication. A noteworthy feature of the case is that, while the accident abruptly took out of service the 30,000-hp. capacity of the plant, electric supply on the entire transmission network continued uninterrupted; few consumers even knew that the system was meeting any unusual condition. Moreover, by remarkably rapid work in planning and executing the penstock repair, the plant was put back into service within two weeks, a feat that was made particularly difficult by the remoteness of the plant, which is located in the mountains 250 miles from headquarters.

Conditions at Time of Break—Just before the break the 30,000-hp. unit (only one unit is installed at this plant) had been shut down by closing the guide vanes of the turbine. The Johnson balanced valve, which is provided at the lower end of the penstock as a shut-off, was left open, and for the time being the water flowed through a pressure-relief valve connected to the turbine casing, which opened automatically as the turbine gates were closed. This valve was closed by action of a slow-moving dashpot, and ordinarily would have remained closed, when the Johnson valve could have been closed safely under no flow. But on the present occasion the automatic control of the pressure-relief valve had been shut off, in order that the draft tube would be unwatered for inspection, and therefore until the Johnson valve could be closed the pressure-relief valve was to be kept closed by water pressure brought through a small pipe controlled by a manually-operated valve.

This latter valve the operator opened, preparatory to closing the Johnson valve; but in doing so he neglected to close a second valve in the same pipe system leading to an ejector. This neglect allowed the pressure-relief valve to open, contrary to the operator's expectations. In consequence, when he later undertook to close the Johnson valve in a way which would have been quite safe under balanced pressure, the full force of flow through a 6-ft. pipe under a head of 680 ft. caused the valve to slam shut, setting up a severe water hammer in the 2,800-ft. penstock.

The Effect—The sound of the sudden closure of the Johnson valve was heard some distance from the plant. It was followed by two other reports, presumably caused by the rupture of the penstock. The penstock broke in two places, one of them about a fourth of the way up, the other in the anchor section just outside the power house. Both sections consisted of lap-welded steel pipe, and in both cases the ruptures were clean breaks.

The upper break tore the pipe open for the length of one section, by a longitudinal rupture on the side opposite the longitudinal weld, crossing the circumferential weld approximately at right angles. In the break near the power house the lower end of one of the thickest sections of the penstock, which was further strengthened by being embedded in a concrete anchor block, was cracked for a length of about 5 ft. The greater portion of this crack was in that part of the pipe embedded in the concrete block. Outside the anchor block the break extended through the cast-steel flange of the pipe, which is some 4½ in. in thickness.

In addition to the loss of two lives, previously reported, the damage was limited to the penstock itself.

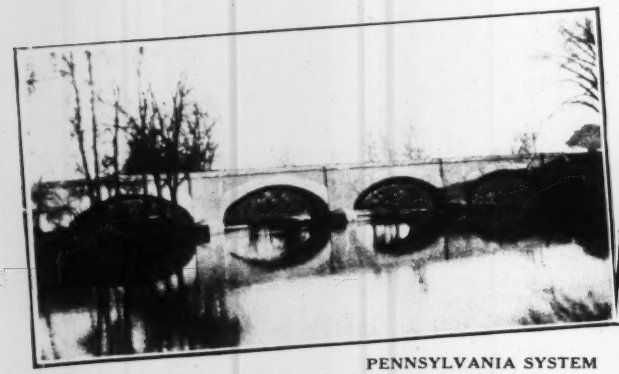
Repair of the Break—In the case of the upper break the ruptured section of the pipe was removed bodily from the line and was replaced by a new section of the same dimensions riveted up in Los Angeles on a rush order. The lower break was repaired by attaching a butt strap over the crack inside the pipe. The butt strap, cut from the upper ruptured section, was bolted in place inside the pipe and was then welded to the pipe shell along the edges. External bands were applied to the pipe to strengthen the repaired section still further, giving to the finished job a greater strength than it had before the break.

French Architects and Engineers Disagree

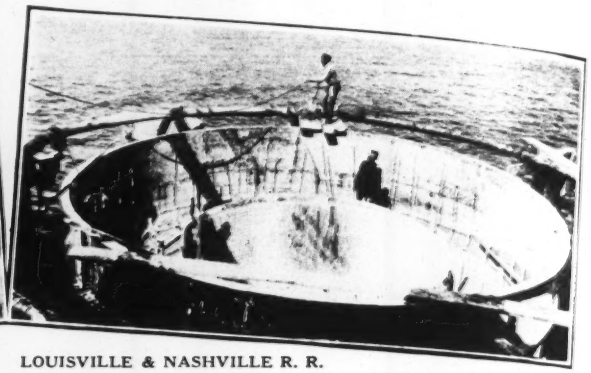
In the city of Paris, France, a discussion is going on regarding the relative functions of the architect and the engineer in municipal work. The building and construction staffs of the city consist of various technical services—subways, sewers, streets and bridges being all separate, and finally an architectural department. This latter department now has charge of the construction of a municipal swimming pool and is paid by commissions of 5 per cent on the cost of the work it supervises. The city engineers, on the other hand, are paid salaries and are required to go through all the public formalities of advertising and letting contracts. The architects are permitted to enter into private contracts with builders. In the case of this swimming pool, charges are being made that the architects have been unduly extravagant and have let the contracts to favored bidders without the public advertising that is required for engineering work. As a result, there is in progress an unpleasant controversy between the municipal architects and engineers.

A Dozen Railroad Construction Projects

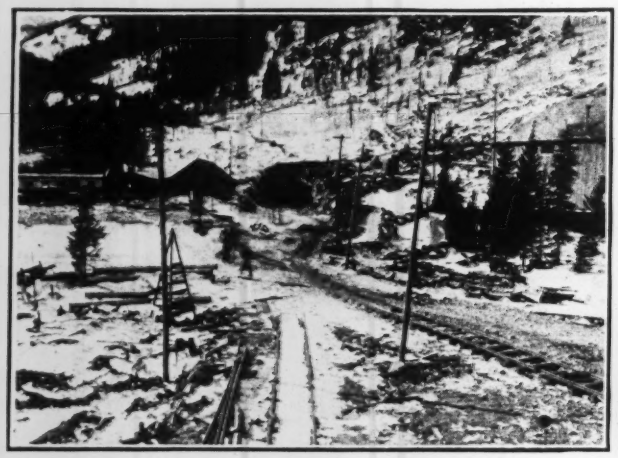
Photographic Record of Progress on Widely-Separated Passenger, Freight and Engine Terminals, Line-Revision Work, Bridges, Tunnels and New Lines



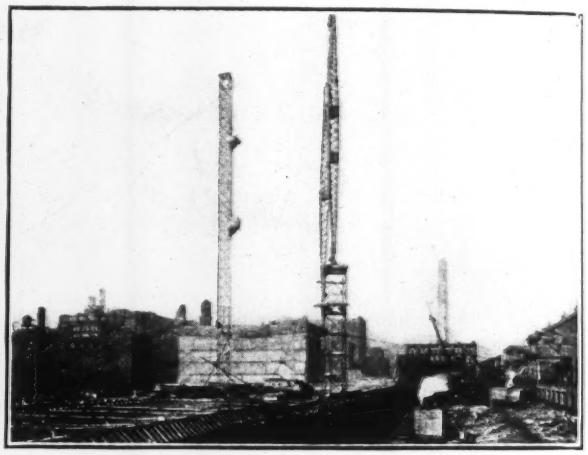
PENNSYLVANIA SYSTEM
Double-track concrete arch bridge over Detroit River.



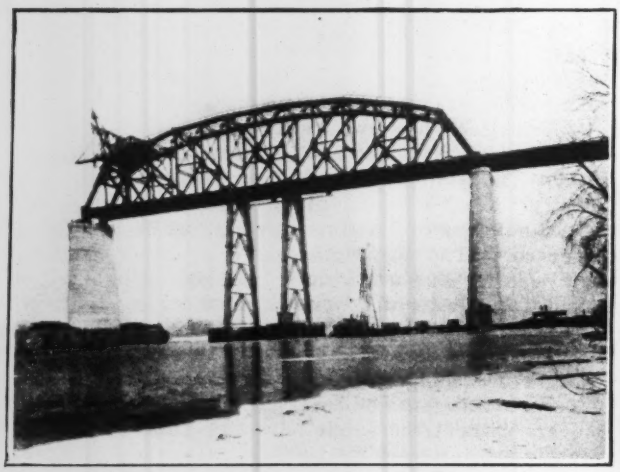
LOUISVILLE & NASHVILLE R. R.
Concreting caisson of pier No. 9 on Rigolets Bridge.



MOFFAT TUNNEL, COLORADO
East portal: pioneer tunnel portal in snowshed at left.



CHICAGO, BURLINGTON & QUINCY
Building new freight terminal at Chicago.



NEW YORK CENTRAL LINES
Erecting span over Hudson at Castleton, N. Y.

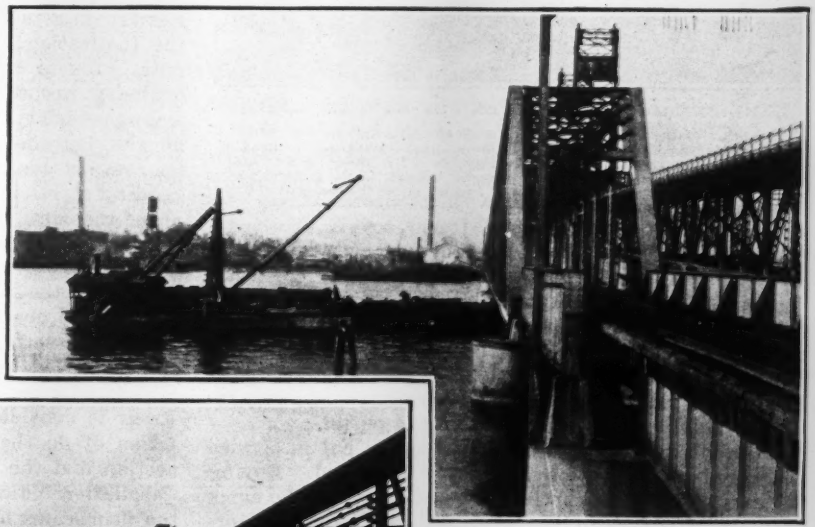
PITTSBURGH, CLEVELAND & PENNSYLVANIA R. R.
Kensington cut on grade and line revision.

SOUTHERN PACIFIC SYSTEM
400-ft. bridge over Colorado River at Yuma, Ariz.

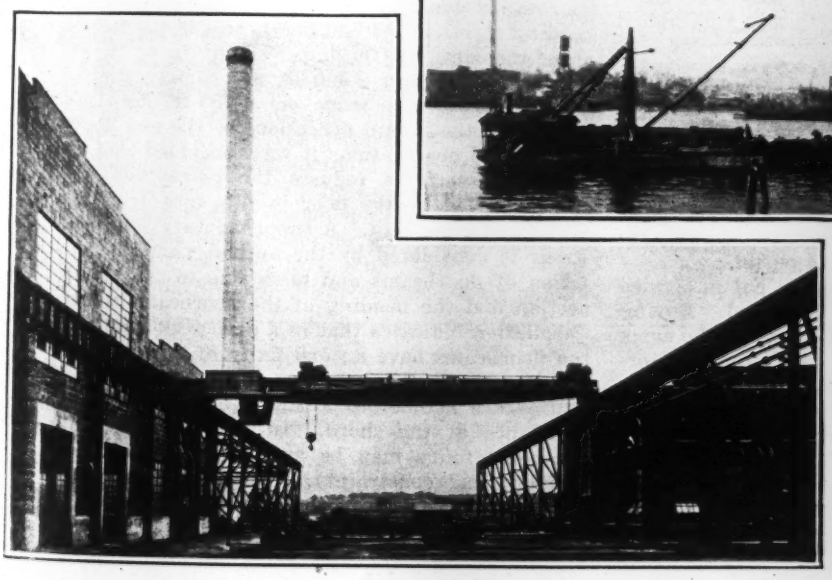
PHILADELPHIA & READING RY.
New passenger terminal at Camden, N. J.

ILLINOIS CENTRAL R. R.
Temporary trestle for train filling on new line in Kentucky.

NORTHERN PACIFIC RY.
Enlarging Greenbrae tunnel for double track.



ABOVE—FLORIDA EAST COAST RY.
Placing caisson, St. Johns River Bridge.



LEFT—C. B. & Q. R. R.
50-ton crane, new Denver shops.

Progress on the Moffat Tunnel Through the Rockies

Headings on Both Pioneer and Main Bores Total 2,920 Ft.—Daily Average 12 Ft. per Heading—Construction Plant

ON THE six-mile tunnel through the Continental Divide of the Rocky Mountain range near James Peak, about fifty miles west of Denver, during the period between Sept. 12 and Feb. 1, there had been driven a total of 2,920 ft. in all headings. By Feb. 1, also, the construction camps had been completed and the greater part of the plant installed.

At the east end, where solid granite was encountered from the start, the 8x8-ft. pioneer or water tunnel has been completed for a distance of 1,015 ft. Crosscut No. 1 was made at a point 450 ft. in from the portal and was run diagonally at an angle of 65 deg. with the tunnel line until it reached the line of the main or railroad tunnel, 75 ft. north. From that point, main headings 8x8 ft. have been driven 122 ft. west and 191 ft. east to meet the incoming heading from the open cut and railroad tunnel portal.

At the west end, as was anticipated, the biotite gneiss and schist encountered are badly disintegrated, so that

HANDLING MUCK AT WEST END OF MOFFAT TUNNEL

At left: compressed-air shovel and electric locomotive with muck train of 36-in. gage in open cut for portal of main tunnel. At right: electric locomotive with muck train of 24-in. gage from heading of pioneer tunnel. The difference in elevation of main and pioneer tunnel necessitates transfer of muck as shown.

timbering close up to the heading has been necessary at all times. The water tunnel at that end has been driven 1,360 ft. Crosscut No. 1 has been driven at a point 300 ft. from the portal, and from its intersection with the railroad tunnel center line main headings have been driven 41 ft. east and 10 ft. west. The approach cut for the railroad tunnel has been completed preparatory to starting the heading from the portal.

As additional equipment arrives and is put in service the speed of excavation is notably increased. During January, electric locomotives arrived to handle the muck trains and replace mules. For the water tunnel, storage battery engines of 24-in. gage will be used; while those in the railroad tunnel will be of the extension trolley type and 36-in. gage. Compressed-air shovels will be used for mucking in the large tunnel, while mucking machines replaced hand mucking in the small bore in February. At each portal two 1,200-cu.ft. 200-hp. air compressors and two 4,800-cu.ft. 100-hp. blowers are in operation. There are also [illegible]plete installations of drill sharpening machinery, [illegible]ge battery recharging generators and machine [illegible] equipment.

With three 8-hour shifts consisting of a [illegible]t boss, two drillers, two helpers and four muckers [illegible]d track men, the average daily progress per heading [illegible]exceeded 12 ft. previous to the arrival of heavy [illegible]ipment. About 180 men are now employed at each [illegible] the release of men from camp construction being [illegible]counterbalanced by the demand created by the opening of new headings. At the east end drifters and at the west end pneumatic hammer drills are used for the twenty-two holes, 6 ft. deep, that are used for breaking each round.

Standard underground surveying methods are being followed, the line being run in from long backsights across the valley from the portals, which in each case have been carefully checked over the Continental Divide, both by alignment and triangulation. For cross-sectioning in the tunnel "sunflowers" are used and are found peculiarly adapted to the 16x24-ft. bore. This instrument consists of an 18-in. disc graduated in degrees and mounted on a tripod equipped with leveling head. It carries an indicating arm for an extension rod which makes possible simultaneous reading of angle and distances to points on the walls of the tunnel. Complete cost records are being kept of the work, in order that the maximum efficiency may be obtained and for the determination of contract settlements.

This tunnel, described in *Engineering News-Record*, Dec. 13, 1923, p. 962, is being built under the direction of the Moffat Tunnel Commission, Denver, Colo., of which R. H. Keays is chief engineer and Clifford A. Betts, office engineer; B. G. Coy is resident engineer at the east end and V. A. Kaufman at the west end. The contractors are Hitchcock & Tinkler, San Francisco.

Chord Action in Bridge Floors

A discussion of chord action in bridge floors by D. H. Remfry has just been published in abstract form by the Institution of Civil Engineers. The author computes, for a single-track 150-ft. through span of ordinary proportions and with single floorbeams of average design, that the floor will carry 11½ per cent of the bottom-chord stress, while with double end floorbeams this percentage rises to 30 per cent. The bending stress in the end floorbeams in the two cases is about the same, 12,000 lb. per square inch; the stringer tension is 900 and 2,400 lb. per square inch respectively. Tests were made on a 150-ft. deck span, by measuring the lateral deflections of the end floorbeams. From these observations it was concluded that yielding in the connections reduces the percentage of chord stress carried by the floor in this case from 26.5 per cent to 24.5 per cent. A supplementary source of floor stress is considered by the author, namely, the interaction of floorbeams and posts due to their rigid connection and the bending of the floorbeams under load. Calculation indicates that in a deep deck span of 100 ft. the floorbeams have an end fixity of 26 to 28 per cent, and in a 150-ft. through span about 11½ per cent, which figures are subject to a slight increase for torsional resistance of the chord. In shallow deck spans the floorbeam fixity may be as high as 80 per cent (of complete end constraint). The stresses in the posts may be increased by 25 to 100 per cent because of this floorbeam effect.

Eliminating Grade Crossings by Highway Relocation

Wisconsin Work in Grade-Crossing Improvement—Opposition of Railroads—An Important Court Decision—Principles of Cost Apportionment Should Be Established

By M. W. Torkelson
Engineer-Secretary, Wisconsin Highway Commission, Madison

THE DANGER due to railroad grade crossings has always been recognized, but little systematic work has been done to eliminate them. Much has been said and written, but actual work has been mostly the result of sporadic activity after a fatal accident. And in the meantime these accidents, with attendant loss of life, continue to increase.

Particularly since 1919, the State Highway Commission of Wisconsin has been endeavoring to do grade-crossing elimination in a systematic way. This was the natural result of increased activity in highway construction due to federal aid. Many improvements involving grade crossings would have created veritable man-traps if the crossings had been continued, and the commission was forced to consider the most feasible methods of promoting public safety at these places. Some of the improvements executed under the federal aid law were selected primarily to eliminate grade crossings.

Public policy in the state, and a statute existing since 1909, required grade-crossing improvements to be executed at joint railway and public expense, and provided that the State Railroad Commission might order such improvements to be made. The Highway Commission has felt that it could not in justice to the public funds for which it was responsible execute these improvements at sole public expense, and therefore has endeavored to secure railroad co-operation, unfortunately with but little success.

Commissions Co-operate—That there was necessity for systematic improvement seems to have been recognized by the railroad commission, since, in 1918, one of its members approached the highway commission with a proposal that the two bodies jointly employ an engineer to inaugurate such systematic work. It was felt by the highway commission that the functions of the two bodies in connection with grade crossing work were so dissimilar as to make it impossible for any single person to represent them both; the highway commission would always appear as a special advocate for the elimination of the crossing, while the railroad commission is a quasi-judicial body. So each body employed its own man. The engineer employed by the railroad commission remained with them for about two years, but when he resigned the vacancy was not filled. The writer, at that time bridge engineer of the highway commission, was put in charge of its grade crossing work, and has continued in it since.

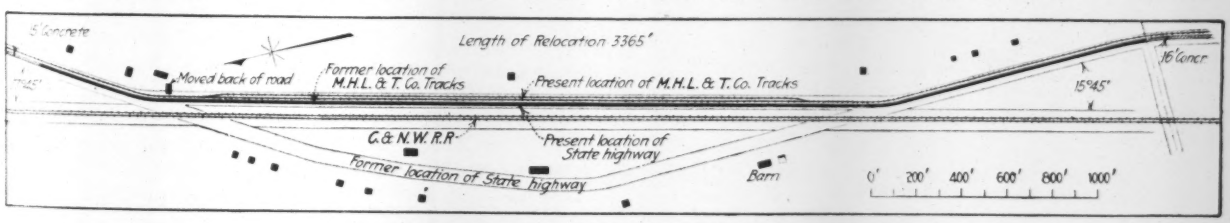
The Relocation Method—Prior to that time, the highway commission had taken part in the elimination of a few grade crossings, and had given the subject some study. It often developed that the problem was not of one crossing alone but of a series of crossings, and the most feasible solution was often through the relocation of the highway rather than through the construction of separation structures.

Much of the discussion of this subject has centered on the separation of grades by means of structures. Thus, the press service of the U. S. Department of Agriculture on July 25, 1923, issued a statement containing the following: "There is only one safe way to prevent accidents where highways and railways intersect. That is by a complete separation of grades by means of a subway or viaduct"; and again, "the agitation for stopping highway traffic at railroad crossings is having the effect of rapidly crystallizing public sentiment against all grade crossings and this will lead to the only right solution of the matter; that is the separation of grades."

Such statements as these confuse the object sought with one of the means of its attainment. The object is to eliminate accidents; the separation of grades by means of structures one of the means to this end. As it has been used in many cases, it is by no means a perfect solution. There is one extreme instance where a viaduct over a double-track railroad broke down under a tractor, which fell on a moving freight train. The destruction caused was just as great, no doubt, as if the tractor had been struck on a grade crossing. There are numerous subways with approaches so crooked and the view so bad that accidents are much more numerous than if the original grade crossing had been retained. Highway overhead crossings are usually less dangerous than subways, but some of these are constructed with such steep approach grades and sharp curvature as to be no improvement over the conditions displaced. While it is true that separation of grades constructed with a proper alignment and gradients is the most effective safeguard possible in most cases, it is also true that the expense involved in these is so great as to make separations in large numbers very difficult to finance.

In much of our work, it has been possible to accomplish a large amount of improvement of safety at a comparatively low cost through the relocation of the highways.

A New Cost Apportionment Law—Under the statutes in force until 1919, the railroad commission had author-


5" Concrete
Length of Relocation 3365'
Moved back of road
Former location of M.H.L. & T. Co. Tracks
Present location of M.H.L. & T. Co. Tracks
16" Concr.
15°45'
C. & N.W.R.R.
Present location of State highway
Former location of State highway
Barn
0' 200' 400' 600' 800' 1000'

HIGHWAY RELOCATION TO ELIMINATE GRADE CROSSINGS

ity to apportion the cost of a separation of grade, but no authority to apportion the cost of relocation. Moreover, it had no authority to close a crossing, however useless it might be, without ordering at the same time the substitution of another therefor, not at grade. The highway commission felt that if it is a reasonable proposition to eliminate a grade crossing by means of a separation structure and to apportion the cost between the railroad and the public, it is equally reasonable to apply the same principle to the accomplishment of the same result by a different method, especially when this can be done more cheaply.

For this reason the highway commission in 1919 asked and secured an amendment to the grade-crossing statute, by which the railroads might be required to participate in the cost of relocations made to divert travel from grade crossings. This provided that in such cases the railroad commission on petition of the highway commission shall issue notice of investigation and hearing, and, if upon such hearing the commission shall find that the railroad will be benefited, the commission shall order the railroad to pay the municipality a sum equivalent to the benefits received.

Arguments in Opposition—Following the enactment of this act, the highway commission instituted a number of actions under its provisions. These were invariably fought by the railroads on the following principal grounds:

1. That the purpose sought to be accomplished was not the elimination of danger, but an attempt by indirect means to saddle the cost of highway improvements on railroads. There was much outcry about the injustice of forcible subsidization of possible competitors of railroads.

2. That the relocation might not divert a very large percentage of the traffic, since the grade crossings themselves often remained; that, notwithstanding the relocation, the public might still continue to use the old road and the crossings thus constitute as great a source of danger and expense to the railroad company as originally.

3. That the railroads' proportions of the cost of the improvements projected were so great as to prove a serious drain on their resources.

The first did not impress the Supreme Court of Wisconsin, as will be seen from the decision quoted hereafter.

There is no rule for the frequency of grade-crossing accidents, but it is axiomatic that accidents will increase with increase in traffic, both on the highway and the railway. It seems reasonable to believe that if the main road can be diverted from a grade crossing which may still remain open for purely local use, the danger will be decreased in a percentage greater, rather than less, than the decrease in travel. Yet in one case where a relocation diverted the trunk highway from two crossings with a double-track railroad, leaving one for the use of ten or twelve farmers, and making it possible to convert the other into a farm crossing with gates used by one farmer only, the railroad attorney opposed the closing of the crossing, and challenged the right of the railroad commission to close it.

Cost and Results—The third argument continues to be urged, although contradicted by the facts. The highway commission has since 1919 concerned itself with 46 operations, involving grade-crossing improvements wherein the amounts the railroads [illegible] be required to pay may be considered as decided. The total amount that all of the railroads in the state [illegible] am and interurban, will be called upon to pay as a result of these operations is $217,288. The amount of public funds expended in connection with the same improvement is, according to the best estimates available, $482,710, or more than twice as much. The result of these operations has been to construct eight separation structures of various types, to close up 30 crossings at grade between state trunk highways and railroads, and four crossings at grade with town roads. The state trunk highway traffic has, in addition, been diverted from 40 crossings at grade. Two new trunk-highway grade crossings have been opened, and three new town-road grade crossings created. Of the two new trunk-highway grade crossings created, one is over a branch line with small rail traffic, and located near a switch at which all trains stop. The other is a new crossing with favorable vision and alignment opened in lieu of two with bad vision and bad alignment, which were both closed. Through a relocation which was a part of the improvement, 80 per cent of the highway traffic avoided the crossings altogether.

These figures show that the cost to the railway companies particularly has been very low. The average annual expenditure of all the roads combined is less than $45,000.

Shortly after the statute of 1919 became effective, a question arose as to its proper construction. It was finally held that the railroad commission was required to ascertain the actual benefits accruing to the railroad companies by relocations, and to fix the benefit.

It was unfortunate that the statute should have been drawn in that manner, because, while the benefits undoubtedly existed, it was generally difficult, if not impossible, to determine their value in dollars, and while the railroad commission entered a number of orders assessing benefits, the basis of their determinations was not stated in more than one or two instances.

Determining Benefits: A Court Decision—Probably the most heavily traveled highway in the state of Wisconsin is State Trunk Highway No. 15, south of Milwaukee. This highway is a continuation of Sheridan Road in Illinois connecting Milwaukee with Chicago. The traffic averages 4,500 vehicles or more daily during eight months of the year, and 1,500 or more daily during the other four months. South of Racine this highway lay east of the passenger line of the Chicago & North Western R.R., except for a distance of about 3,000 ft. at the one point shown on the drawing. Between the crossings the interurban railway, which occupies the east side of the highway between Racine and Kenosha, was located along the east right-of-way line of the North Western, thus avoiding them both. All parts of the highway between Racine and Kenosha were paved with concrete before 1916 except that portion which might be involved in the inevitable future grade-crossing improvement.

Though the railroad had recognized the dangerous character of the situation by the voluntary installation of 24-hour flag service at both crossings, the highway commission felt that the continuation of the grade crossings for the main road was impossible, and as early as 1915 came to the conclusion that the only feasible improvement in the crossings was that eventu-

ally executed. The sharp angles of crossing and the extremely heavy work involved, made the expense of separation prohibitive. The solution adopted was to shift the electric railway to the east between the two crossings to give room for the construction of the trunk highway between the electric and the steam line.

Negotiations to obtain the voluntary co-operation of the railroad in this project were ineffective, and proceedings were therefore brought before the railroad commission in 1919. The estimated cost was $17,000 (exclusive of paving), almost all of which was required for the acquirement and construction of a new roadbed for the interurban railway. It was contended by the North Western that the relocation was unnecessary; that the crossings were reasonably safe, as proved by the fact that no accident had occurred since the installation of the flag protection. The railroad was, however, ordered to pay $17,000. It applied for a rehearing, but by the time of the rehearing the cost had advanced to $29,500. Upon the rehearing, the railroad commission in March, 1921, ordered the continuation of both crossings and the old road for the use of the people living in the eight residences along it, the substitution of automatic visible and audible signals at the crossings in lieu of the flag service, and the payment of $29,000 by the railroad.

To determine the amount of benefit, the railroad commission computed the difference between the annual cost of the flag service and the annual expense connected with the automatic signals, and found this to be $4,410. Capitalized at 10 per cent, this gives $44,100, and more if capitalized at lower interest rates. It was not considered that any assessment should be greater actually than the cost of construction, the express wording of the statute notwithstanding, and the railroad commission fixed the amount at $29,000.

What the Court Said—The railroad appealed the order, first to the circuit court of Dane County, and, upon receipt of an adverse decision in that court, to the Supreme Court of the state, where another decision adverse to them was rendered. Referring to the railroad's contention that the improvement was designed simply to saddle the cost of highway construction upon it, the Court said:

> If the plaintiff's premises be conceded, the conclusion naturally and irresistibly follows: When this improvement is viewed as a whole, it appears with certainty that the purpose and object of the opening of the highway along the easterly line of the right-of-way of the plaintiff company was undertaken for the primary purpose of diverting a considerable part of the traffic from the old route and thereby protecting the public from possible injury. *Were the tracks of the railway company not so located as to create two dangerous crossings, there would have been no need for the relocation of the highway or the establishment of a new way.*
>
> The state has ample power in the exercise of the police power to authorize the relocation of the highway in order to protect the public and to cause the cost thereof to be assessed against the Railway Company. Polk vs. Railroad Commission, 154 Wis. 523; Superior vs. Roemer, 154, Wis. 345; Milwaukee vs. Railroad Commission, 162 Wis. 128; C., M. & St. P. Ry. Co. vs. Milwaukee, 97 Wis. 418.
>
> The purpose of the statute is not as argued to establish a new way but to divert traffic so as to avoid the crossings and thus promote public safety.
>
> The fact that concurrently with the opening of the new way, the highway throughout its length was resurfaced with concrete we regard as immaterial so far as the consideration of this question is concerned. The railroad commission found that a very material part of the traffic ordinarily passing over these crossings would be diverted in such a manner that it would not pass over either crossing. The old crossings were retained for the convenience of those who had improved their property on the westerly side of the right-of-way in reliance upon the fact that the highway was adjacent to their premises. The public authorities had just as much power to deal with the situation as they would have had had the two crossings been eliminated and the old highway vacated. The power of the legislature to deal with the situation in such a way as to promote the general public interest is not limited to any particular method or any particular means. It may deal with it in such a manner as will best promote the public interest, unless its power in that respect is in some way restricted by constitutional provisions.

After an appeal to the State Supreme Court for a rehearing had been denied, the assessment was paid, together with interest. During the period after the last railroad commission hearing and before the opening of the relocation, there were three serious accidents, notwithstanding the continuous flag service.

Experience with the statute under which the above decision was reached indicated its imperfections. Ordinarily, no mathematical basis for the assessment of benefits could be determined, and in this one case where there was such a basis, it probably worked a hardship. The statute was amended by the Legislature of 1923, and the cost of improvements designed to promote safety at grade crossings will hereafter be apportioned.

The Cost-Apportionment Problem—In this case, as in practically all others outside of the cities, the physical solution was simple; the whole problem was to settle the proportions of the cost to be paid by the parties in interest. The decision, though a clean-cut victory for one side of the controversy, left the other side as determined as ever to fight grade-crossing improvements.

So far as the writer knows, the principles which should govern the apportionment of the cost of improvements at railroad crossings have never been formulated. There is very little, if anything, in the orders of the railroad commission of Wisconsin, the only such body with whose decisions the writer is familiar, to indicate the basis on which apportionments of the cost of separation structures have been made. Apparently there have been two general methods: (1) Either fixed percentages (60 to 75 per cent) were assessed against the railroad, or fixed amounts to be paid by one party; (2) the cost of the separation on the railroad right-of-way has been assessed against the railroad, the balance against the public. But nothing has been written to indicate the line of reasoning through which these apportionments were selected as being proper, or which method should govern in any particular case.

The problem is not one of the highways alone. The railways are at least equally concerned. The damage at a highway grade-crossing accident is by no means confined to the highway traveler. The rear-end collision on the New York Central R.R. at Forsyth, N. Y., on Dec. 9, 1923, so destructive to life, property and railroad prestige, was due indirectly to a highway grade-crossing accident.

There must be actual work, not mere discussion and the consequent procrastination. If the railways will come in and help now, when the main highways of the United States are being constructed in their permanent locations, this joint problem can be worked out with a minimum of expense to both parties.

Railroad Valuation, A Brief Survey

An Outline Sketch of the Origin and Growth of the Valuation Movement Leading Up to the Federal Act, What Has Been Achieved to Date, and Present-Day Prospects for a Useful Outcome

By William D. Pence
Consulting Engineer, Chicago

VALUATION and railroad regulation questions in many of their aspects have probably never before, at least in a national sense, been dragged closer to plain politics—or politics closer to these questions—than for some time past, and particularly just now. Largely for this reason, in attempting a condensed review of some phases of valuation for the reader who may not have followed the course of these recent movements at close range, it seems necessary to depart somewhat from the line of technical thought.

In attempting to understand the present situation it is necessary to refer to former movements in public regulation and to the earlier stages of some of the larger controversies still more or less in active progress.

Federal Valuation

Its Origin—Valuation of public-service properties, long recognized as an important incident of public control—of taxes, of rates, of security issues, of consolidations, of public purchase—received fresh emphasis in the public mind from the extended discussions at Washington preceding the enactment (in March, 1913) of the federal Valuation Act, known as section 19a of the Interstate Commerce Act. This legislation called for the inventorying and valuation of the quarter million road miles of steam railroad in the country.

How the work was carried out has been described many times. The inventory work and the basic processes in both field and office were fairly started before the war, and by 1917 such progress had been made that the field work and to a considerable extent the office work could be continued without interruption.

Early Views—No one, probably, at the beginning fully understood the problem in its many angles, and but few even now grasp the hugeness of the burden imposed on the Interstate Commerce Commission and in turn on Director Prouty just ten years ago. Samuel Rea's comment in forecast, was, "A mighty task," and he would doubtless use no weaker phrase today. Judge Cotton, eminent railroad counsel, who knew the problem, was quoted in substance as being finally favorable to the project, "Although at one time distinctly opposed to railroad valuation, now that the work has been undertaken by the government and is well under way it is seen to be fully justified even if nothing more were ever done than to set up in identical and orderly form from the physical elements making up the several carrier systems, impartially priced for comparison."

Achievement—Following are a few details of progress drawn from the commission's 1923 report. "Of 327 tentative valuations served, on or prior to Oct. 31, 1923, 127 have become final because no protest was filed within 30 days. Hearings on protests have been had and concluded in 105 cases. In 16 other cases hearings have been commenced and continued to later dates. Twenty-five cases are now set for hearing before our examiners. Final arguments have been had in 27 cases and 9 others have been assigned for argument in the near future; 67 cases have been heard and submitted without argument. As of Oct. 31, the Bureau had completed 183 tentative reports covering 242 properties and 26,863 miles."

After ten years of prodigious industry and the direct expenditure of close to a hundred million dollars, much still remains to be done, and no one can forecast the date of completion. Nevertheless, it seems certain in view of the great importance of the final results to the highly tense political and economic issues centering on the transportation problem, of which the valuation is but a part, that the means will be found for completing the project. In any event, if abandoned by the government now or later, the individual carrier systems would perforce round out the results.

Of the above round hundred million dollars total cost, about one-fourth has been met directly by government appropriation. The government also absorbed indirectly much of the valuation costs during the period of wartime operation of the railroads. The cost represents 5 mills on the dollar of value, and the government's expenditure 1¼ mills on the dollar.

How the Valuation Movement Developed

Early Valuation Movements—The earlier influences in the states which led up to the 1913 enactment seem to divide at about 1900. Previous to that year there had been the appraisal of a portion of the Union Pacific system (in 1886-87) in connection with the approaching government settlements, made by Richard P. Morgan in association with Charles Francis Adams, then head of the Union Pacific and nestor of prewar railroad regulation, in the north; and the Texas stock and bond appraisals of the middle nineties under Reagan, in the south. In the same year (1898), with the epoch-making *Smythe v. Ames* decision (the Nebraska freight-rate case), what appears to be the real origin of the widespread valuation movement which culminated fifteen years later in the federal act, was initiated in the Detroit traction appraisal under Mayor Pingree. This also apparently was the beginning of a contest which ended only recently in the purchase of the Detroit traction property by the city under Mayor Couzens. Two years later began, under Dean M. E. Cooley's direction, the first of the Michigan statewide appraisals, in connection with Governor Pingree's taxation plan of 1900; the scope and purpose of the Michigan appraisals were developed in later years.

The next notable step was the adoption of the idea by Governor La Follette of Wisconsin in 1903, in his *ad valorem* tax reform program, applied first to steam railroads only but later (1905) broadened to cover the electric roads as well. Provision was also made in the 1905 act creating the new railroad commission, shortly before La Follette's retirement as governor, that all appraisals should become available for use in rate matters. The principal states to which there was further spread of railroad appraisals of the Michigan type were as follows: Minnesota (1905-08, rate cases); Washington (1908, rates); New Jersey (1910, taxation); Massachusetts (1911, New Haven validation).

State Commissions Set Up—About midyear 1907 be-

gan the far-reaching public utility commission movement through the enactment of two pioneering laws. One was in New York under Governor Hughes, providing two commissions, with Stevens chairman of the up-state body. The other was in Wisconsin, where regulation was made to cover alike the publicly and the privately owned utilities commission. Following the lead of these two states, similar laws were passed in rapid succession by most of the states.

Opposite Views on Use of Valuation

Finding in Ex Parte 74—In the earlier war period there was still some discussion of the possible use of the valuation results in connection with government ownership. One authority (Samuel Untermeyer) in an address to investment bankers even outlined a plan for the possible use of the government borrowing margin in paying for the roads automatically. With the passing of the impulse to purchase, in the period of military necessity, the opponents of valuation still insisted that the valuation results could not be applied to railroad rates, unless in some broadcast or blanket sense.

Although not in itself regarded as a valuation act, the valuation clause of the Transportation Act of 1920 has drawn one of the heaviest attacks thus far directed against any of its provisions, following on the finding by the commission of an "aggregate value," namely, $18,900,000,000, in Increased Rates (*Ex parte* 74, July, 1920). Because of the prominence now given to this "finding," special interest attaches to the provision of the Transportation Act under which it was reached by the commission:

> In the exercise of its power to prescribe just and reasonable rates the commission shall initiate, modify, establish or adjust such rates so that carriers as a whole (or as a whole in each of such rate groups or territories as the commission may from time to time designate) will, under honest, efficient and economical management and reasonable expenditures for maintenance of way, structures and equipment, earn an aggregate annual net railway operating income equal, as nearly as may be, to a fair return upon the aggregate value of the railway property of such carriers held for and used in the service of transportation.

The commission in its review of facts and evidence before it in *Ex parte* 74 made the following reference to the then status of its own valuation work:

> While the valuation of the railroads under section 19a of the Interstate Commerce Act is still incomplete, the work has progressed so far that the results are of value and informative in reaching the determination we are now required to make. So far as the work has produced results, either as to particular roads, or as showing general tendencies and principles, we have given consideration thereto. As will appear from examination of our various valuation reports, and from section 19a itself, our investigations under that section are designed to give information as to the original cost of the property, the cost of reproduction new, the accrued depreciation, the amount of the investment, the corporate histories of the properties, the values of the lands, and other values and elements of value, if any.

As an interesting sidelight on the elements considered and also those not taken into account in arriving at this finding, the following quotation of the statement made by former Chairman Clark before the Senate Committee in January, 1921, has recently been cited:

> Stocks and bonds were not considered at all. The question of capitalization was not thought of. It is the fair value as closely as could be estimated and approximated at that time of the physical property which was devoted to the transportation service. We had a mass of information gathered in our valuation work, which is not in complete form to be given out in the form of reports and findings, and the Transportation Act specifically authorized us to avail ourselves of all the information we could. The principal features that we used in our valuation are as of 1913 and 1914. We fixed the unit on a given railroad valuation as of June 30, 1914.

The mobilized results of the bureau's figures as far as available at the time, shortly before the close of the hearings in *Ex parte* 74, were submitted in the "Hulme Exhibits," covering a comparison of the combined preliminary engineering and land report totals (the latter in part approximate), as against the carriers' total "Investment in Road and Equipment," for fifty Class I carriers aggregating around 50,000 road miles (averaging nearly 1,000 miles per carrier). This showed the bureau totals roughly $1,000 per mile of road in excess, on an average of about $60,000 per mile total; that is, the total of the available results indicated an excess of less than two per cent over the carrier's book figure. (Subsequently similar rough comparisons showed the bureau figure considerably below the road and equipment total, with the probability that it will remain below to the end of the work.)

The book cost of road and equipment shown in *Ex parte* 74 by all classes of carriers reporting to the commission, as of Dec. 31, 1919, was as follows for the three territorial groups: Eastern, $9,038,194,615; Southern, $2,183,923,124; Western, $8,818,454,872; Total, all groups, $20,040,572,611. The commission's finding in the case was "that the value of the steam-railway property of the carriers subject to the act held for and used in the service of transportation is, for the purpose of this particular case, to be taken as approximating the following: Eastern group, $8,800,000,000; Southern group, $2,000,000,000; Western group, $8,100,000,000; Total, $18,900,000,000."

Commissioner Eastman, in a concurring opinion in *Ex parte* 74 in part comments as follows:

> Upon the evidence now before us any present finding as to "aggregate value" is without adequate foundation. I know the good faith in which the majority have proceeded, but I feel sure that it is not in the public interest and I cannot believe it necessary under the law that such an estimate should now be made. It will almost certainly be misunderstood and misinterpreted and may have an unconscious influence upon our valuation work for the future from which it ought to be free. As a side light upon the situation, it will, I think, be conceded that something more than estimates of this kind will be necessary when it comes to enforcing the closely related portions of the act which provides for a division with the government of any income which a carrier may earn in excess of 6 per cent upon value.

Progressive Conference—A conference known as the "National Conference on Valuation of American Railroads", called by members of the congressional bloc, met in Chicago on May 25, 1923, for the avowed purpose of forcing action from the Interstate Commerce Commission in certain matters, notably in connection with finding and also considering "original cost" in the valuation of steam railroads under the provisions of the Valuation Act (section 19a). During the sessions much stress was laid in the discussions on the Brandeis-Holmes concurring opinion (in support of the Massachusetts investment measure for the rate base) in the Supreme Court decision of May 21 in the Southwestern Bell Telephone case, where the majority opinion favored the reproduction cost. An incident in the closing public session centered in W. J. Bryan's reference to his own contention in the Nebraska freight-rate case (*Smythe v. Ames*) for the

reproduction-cost measure under the conditions prevailing during the nineties—in effect taking frank issue with the main contention of the conference, as set out in the resolutions, which were made to cover the local municipal type of public utility as well as railroads.

The movement initiated in this conference was marked by the following later events: Immediate filing with the Interstate Commerce Commission of petition asking among other things that valuation cases be recommitted and that original cost be found; argument in July; decision in November in effect denying petition; introduction in U. S. Senate (January, 1924) of bill proposing radical amendment of section 19a (the Valuation Act), bringing it to the "prudent investment" measure for rate base.

Among the claims set up by the Chicago conference was one regarding the alleged debatable range—a speculative figure which afterwards gained wide currency—in the value, as determined or yet to be determined as a whole, of the steam transportation properties of the country. This range or "spread" was placed at ten billion dollars, from minimum to maximum.

Tendencies

The Interstate Commerce Commission in the beginning of its valuation work under the Valuation Act proper showed the same reluctance in finding final values which marked the earlier work of certain of the state commissions when confronted with the baffling condition of a lack of known specific purpose in the valuation findings about to be made. Like the state commissions also, the federal commission early showed a leaning toward a formula basis, and with the adoption later of the rate-base purpose for the findings this disposition has shown no marked signs of abating, unless in the very latest cases. Following is a condensed statement by a close observer of the commission's findings of tentative values:

. . . It has issued 329 tentative valuations in which there is a finding of "final value" designated as "for purposes under the Act to Regulate Commerce," this being obviously intended not as a determination of real value, but a determination of a rate base on a basis of cost. The aggregate value found for such properties was $2,898,000,000. An analysis of the figures shows that a cost formula has been generally employed although the same formula has not been applied in every case. In a very large number of cases, and in so great a number that obviously it is not by mere coincidence, it occurs that the addition of the cost of reproduction less depreciation, and the acreage value for non-railway purposes of the land, together with a sum which is 5 per cent of the preceding two amounts, will produce a figure, to which the "final value" (reported in round figures) is very close. Taking the 329 tentative valuations as a whole, the final value found is 5.6 per cent in excess of the aggregate cost of reproduction less depreciation and land value figures. . . .

In the two important "key case" decisions (of Sept. 11, 1923) on the San Pedro and the Atlanta, Birmingham & Atlantic roads, the commission sets up the basis of its findings by majority and individual opinions, but makes it clear that the findings thus far pertain to rate-base values and that the commission has still to face the other important phases—the findings for purposes of security issues, recapture, purchase, etc. The two cases referred to pertained to carriers having valuation dates of prewar time (June 30, 1914). The commission has yet to announce the basis of findings for carriers having valuation dates in later years during the period of rising prices, and also the basis for adjustments of value to the present time.

The outstanding post-war decisions, the Southwestern Bell Telephone case (of May 21, 1923) originating in a rate proceeding before the Missouri commission, brought out in the majority opinion definite support for reproduction cost as a principal measure of value, and in the concurring opinion (Brandeis-Holmes) support for the "prudent investment" basis as reflected in the two paragraphs below.

(Majority) It is impossible to ascertain what will amount to a fair return upon properties devoted to public service without giving consideration to the cost of labor, supplies, etc., at the time the investigation is made. An honest and intelligent forecast of probable future values made upon a view of all the relevant circumstances, is essential. If the highly important element of present costs is wholly disregarded such a forecast becomes impossible. Estimates for tomorrow cannot ignore prices of today.

(Brandeis-Holmes) I concur in the judgment of reversal. But I do so on the ground that the order of the State Commission prevents the utility from earning a fair return on the amount prudently invested in it. [Followed by an exhaustive discussion of the "investment" measure of rate-base values.]

Whether, with a persisting minority of the Supreme Court (as in the years of the Granger cases) and with a like division in the Interstate Commerce Commission, the movement of the near future is to be toward or away from the present trend of the majority opinion in the Missouri case is difficult to forecast. Whatever the immediate trend, however, with the flow of time and investment on the present higher price level the contrasts of the two cost measures tend to decrease.

Whether speaking of valuation, of regulation, or of the general public movement in which valuation is apparently to remain an important phase, reference may well be made to one or two present tendencies which give promise of a satisfactory outcome to these questions. One is the disclosure of a desire to find common ground between groups not ordinarily in contact, and to work out productive association of such groups. To illustrate, there is the just-mentioned Chicago valuation conference of May last, in which affiliation of idea between the least conservative and the most conservative turn of mind was promoted. Again, in a discussion of the transportation question from the standpoint of organized business, both sides were considered in the sessions of the U. S. Chamber of Commerce in New York earlier in the same month. Evidence is to be seen lately (in spite of some signs to the contrary) that the average citizen, the ultimate patron, is doing some thinking on his own account.

Fully as important is the discovery that it may not have been all gain to the railroads to be wholly shorn of their "friends the enemy," the state commissions, the loss of which has been one of the supposed blessings to the interstate carriers in these postwar days. The readiness with which the local utilities use their proximity to both the commission and the public in bringing from hiding the investor's dollar suggests that such a commission may help as well as hurt a utility.

Finally, it is coming to be seen that successful *regulation* must reflect these several elements: (1) An adequate service; (2) charges reasonable to the patrons and in the long run assuring to the investing public financial stability and attractiveness; (3) no discrimination as between patrons or groups of customers; (4) identical treatment for the publicly and the privately owned utility; and (5) in all this, a due regard for the rights and relationships of other utilities and the public.

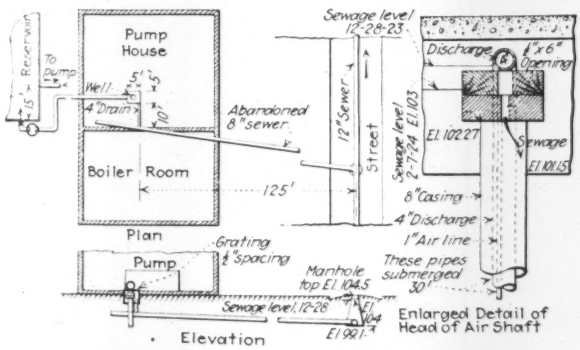
Serious Typhoid Epidemic Caused by Drain-Sewer Connection

Raw Sewage Pumped Into Water Supply Seven Hours at Santa Ana, Calif.—230 Typhoid Cases Reported in Three Weeks

A SEVERE epidemic of dysentery that occurred early in January in Santa Ana, Calif., a southern California city of 15,500 population in 1920, affected a majority of the residents and was followed by a serious typhoid epidemic. Up to Feb. 28 there had been reported 238 local cases, with 14 deaths, but the full effect of the polluted supply will never be known for Santa Ana is on the Los Angeles-San Diego coast highway and reports of alleged infection as far East as St. Louis and Illinois points have been received up to the date just mentioned.

R. F. Goudey, southern division engineer, State Board of Health, traced the cause of the epidemic to sewage that gained access to one of the supply wells after a heavy rain on Dec. 27. Thus the actual date on which pollution occurred is known. During the enforcement of a rigid quarantine a record of each typhoid case is being kept to determine all facts of epidemiological value that may be learned from such a large number of simultaneously infected cases. Dysentery appeared five days after the pollution and typhoid cases began to be reported after about the sixteenth day. A report on the complete results of the observations now under way will be prepared by the California State Board of Health.

The source of pollution, wholly unknown when the epidemic broke out, was found to be a drain in the pit or overflow chamber around the top of the casing of one of the wells from which the city's water supply was drawn. These wells range in depth from 350 to 1,000 ft. Years ago this was a flowing well and a concreted pit around the top of the casing was built to catch spillage and wastage. This pit was drained by a 4-in. pipe about 10 ft. long that led directly into an old 8-in. sewer

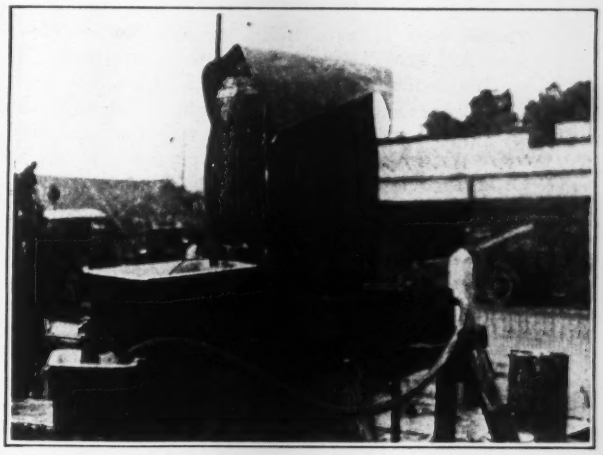


WELL LOCATION AND SEWER CONNECTION

lateral. The lateral had been left in a street that was abandoned before the pump house was built and hence although still leading into the trunk sewer, the lateral for a long time has had no other connections than the 4-in. drain. In the years during which water has been pumped from the well there was no spillage and overflow to be drawn off and, although the pit could be opened for inspection by removing a wooden grillage in the concrete floor of the pump house, there was rarely any occasion for workmen or operators to raise this grillage and the drain with its sewer connection was unused and forgotten.

On account of the rapid growth of the city, the sewerage system has been greatly overloaded in recent years. The 12-in. main in front of the pumping plant, to which a population of about 15,000 is now tributary, became overloaded and at times, particularly when storm water increased the flow, was subjected to back pressure.

The level of sewage in the manhole near the pumping plant, observed on Dec. 28, indicated that on that date a back-pressure head due to storm water was sufficient to back up sewage in the abandoned 8-in. lateral and thence through the 4-in. drain so that the pit around the well casing was flooded to a level some 2 ft. above the top of the casing. As there was ample opening at the top of the casing and around the discharge pipe, raw sewage doubtless flowed in large quantities directly into this well as long as the back pressure continued. On Dec. 28 the pump drew from this well for seven hours at the rate of 168,000 gal. per day, discharging directly into one of the nearby reservoirs that stores the city's domestic supply. The quantity pumped in this period was such that dilution of sewage in the drinking water was probably about one to ten and reached consumers within an hour after leaving the sewer.



EMERGENCY DOSING DEVICE; SANTA ANA

Barrel is covered to prevent deterioration of hypochlorite of sodium by sunlight. The 1-in. hose carries water to increase velocity of hypochlorite and aid admixture with water in pump intake below.

When the seriousness of the epidemic brought about a rigid investigation of all possible sources of pollution, water supply and sewer systems were tested by the use of charges of dye and by backing up the sewage while close observation was made of possible points of contamination. Back pressure thus caused in the sewer system produced a repetition of the Dec. 28 flood-water condition and it was then that the raw sewage was discovered flowing directly into the well casing.

Heroic measures were at once used to prevent a repetition of the epidemic. Pumping from the well was stopped and, in order to disinfect the distribution system, chloride of lime at the rate of 50 lb. p.m.g. was immediately put into the suction side of a pump which delivers into the distribution system from another reservoir. The first dosage was an emergency measure for

which the chemical was simply mixed in a pail. Dosing in this manner was continued for a few hours until an improvised uniform dosing device could be put into service. By the following morning a porcelain orifice box was in use with which sodium hypochlorite at the rate of 2¼ lb. of available chlorine per million gallons was put steadily into the system.

The reservoir into which the polluted water had been pumped was emptied by the city fire department and the contaminated well was disinfected and plugged with concrete. All pumps that had handled polluted water were opened and sprayed with sodium hypochlorite. After these measures the water distribution system was tested on the following day and found to be free from pollution. However, the reservoir into which the contaminated water had been pumped was not put back into service until eight days later, during which time it was thoroughly cleaned and carefully disinfected.

Several changes in the water distribution system are being made including the replacing of riveted-steel suction and low-head gravity lines with cast-iron pipe. During these changes the water supply is being treated with sodium hypochlorite and a close bacteriological check maintained.

This source of contamination is now believed to have been the cause of less serious outbreaks of water-borne diseases that have occurred from time to time in Santa Ana. Bacteriological tests of water from this well made at times when the city's other sources of supply were also tested, repeatedly showed it to be safe. In fact, it is thought that the well doubtless was safe at the times tested, because sewage that occasionally flowed into it was promptly pumped into the water system and the infiltration of pure water into the well flushed it out constantly and kept the well clean between the times when back pressure brought in sewage.

No back pressure had obtained in the Santa Ana sewers for some time prior to Dec. 28 so that the date of this very extensive pollution is accurately known.

Getting Publicity for Technical Societies

AMONG the engineering associations which make a practice of cultivating newspaper activity in the interests of the profession and the public is the Engineers Club of Minneapolis, and the following is a brief abstract of its publicity committee's report for 1923.

The publicity committee should see that advance notices of committee meetings are given to the papers. On our addressograph list are plates for the city editors so that they receive our postcard notices. If the meeting is particularly important it would be advisable to furnish them appropriate copy. After monthly meetings, if reporters are not present, it is necessary to call at the newspaper office and give a story which can be used in the morning paper. If you prepare a story or are able to secure a manuscript of what the speaker says, you will obtain much more space in the paper. If the newspapers are given typewritten material in advance they are far more likely to print a good long story. If they have to write the copy, they will not write so much. It is difficult for the newspaper writers to attend the noon-day lunches, but if you will make some notes and visit the newspaper office, the city editor will furnish a writer to take your memoranda, from which he can build a story.

One of the difficulties encountered was in obtaining the quantity of newspaper publicity to which it was felt the club was entitled. However, the following general principle is the seat of the question: Newspapers are anxious for news; the club is anxious to get publicity; and as soon as the club activities become of general news interest to the citizens, newspaper publicity will follow automatically.

Roadbed Drainage and Crossing of Chicago Sewer; I. C. R. R.

Siphon Outlet for Tile Drains—Double Layer of Slabs Carries Tracks and Loads Sewer Having Internal Pressure

EXCEPTIONALLY thorough provision for roadbed drainage has been made necessary on that part of the Chicago terminal lines of the Illinois Central R.R. between 29th and 39th Sts., where depression of the tracks in connection with the extensive roadbed and municipal improvements along the lake front has put the subgrade very close to the water level of Lake Michigan. A siphon passes the main outlet of this drainage system under a 20-ft. sewer and has separate facilities for dry weather and storm water flow. Since the top of this sewer is near the new subgrade, special construction was necessary to carry the tracks over it and to protect the sewer from destruction by upward water pressure, as the dead-load placed upon it by the normal track construction is not sufficient to resist this internal pressure.

For lateral drainage on this 6,000-ft. stretch of line the 250-ft. right-of-way is crowned 1½ ft. at the center, as shown in Fig. 1. The base of rail of the tracks adjacent to both sides of the right-of-way at the lowest point of the depression is at an elevation of 4 ft. and that of the track in the center of the right-of-way 5.5 ft. above mean lake level.

Sub-Drainage—Sub-surface drainage is provided by

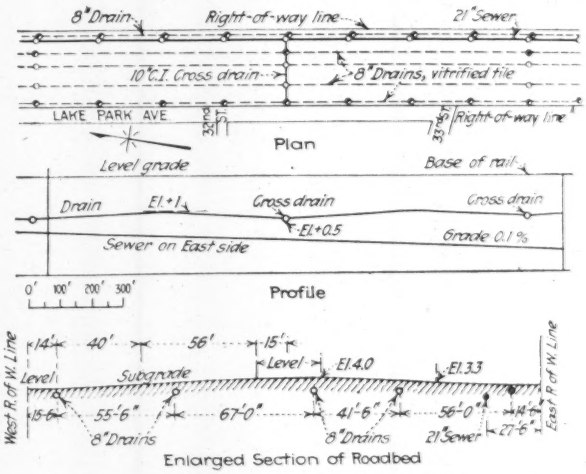


FIG. 1—TILE DRAINAGE FOR DEPRESSED TRACKS

five parallel lines of 8-in. vitrified pipe of bell and spigot type, having the joints calked with oakum only. This arrangement is shown in Fig. 1 and it will be seen from the profile that the drains are laid in longitudinal drainage planes, with sags or valleys at intervals of 800 ft. In each sag, there is a transverse drain of 10-in. cast-iron pipe connecting the five longitudinal lines. Along the two outer drains, which are located at the low sides of the right-of-way, there are combined manholes and catchbasins 200 ft. apart. The tops of these catchbasins are of the open type to provide drainage from the surface during periods when the subgrade is frozen and the sub-surface drainage is thus ineffective.

Along the east side of the right-of-way and at a lower level than the drains, a vitrified pipe sewer 18 to 24 in.

in diameter is laid to serve as an outlet for the drainage system. Both sewage and sub-surface drainage are discharged into a 16-ft. intercepting sewer leading into the 39th St. sewage pumping station on the lake front. Direct connection to this 16-ft. sewer is prevented by a 20-ft. brick discharge sewer in 39th St., which latter sewer leads to the Chicago drainage canal.

An inverted siphon provided to pass this obstruction, as shown in Fig. 2, consists of one line of 8-in. and one line of 14-in. pipe, the horizontal lines being embedded in the ground and the vertical lines placed in concrete shafts. The 24-in. pipe sewer along the right-of-way discharges into a manhole from the bottom

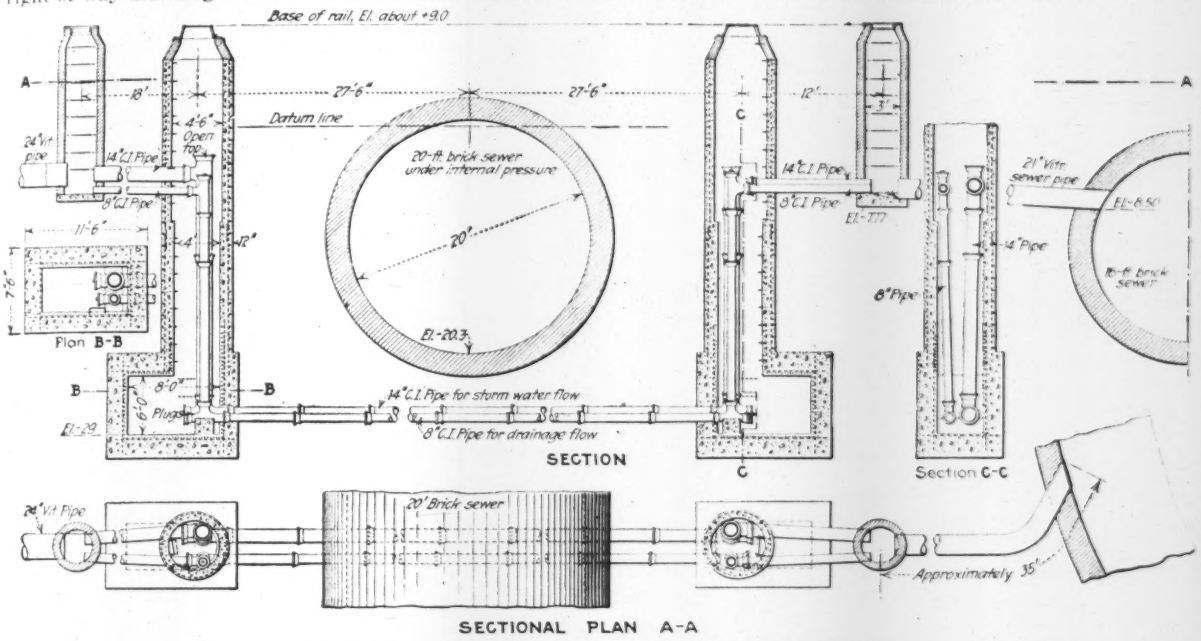


FIG. 2—TWIN SIPHON PASSES DRAINAGE UNDER SEWER

of which a pipe leads to the 8-in. siphon for sewage and dry weather flow. When storm water from the drains increases the flow the water rises in the manhole until it reaches a pipe connected to the 14-in. siphon. Both siphons discharge into another manhole from which a line of 21-in. vitrified pipe leads into the 16-ft. sewer.

Sewer Protection—An unusual type of construction was required to protect the 20-ft. brick sewer and to carry the railroad tracks over it, since this sewer is subject to internal upward pressure, while with the depression of the tracks the level of the base of rail is only 6 to 7½ ft. above the crown of the sewer instead of 15½ ft. as formerly. This special construction is shown in Fig. 3.

The westerly 122 ft. of the 20-ft. sewer crossing the right-of-way was constructed with a shield and the remaining portion by the open cut method. Investigation showed that the old lines of Wakefield sheeting, about 30 ft. c. to c., driven on both sides of the sewer when it was constructed, were still in good condition. For the protection built over this portion of the sewer, approximately 68 ft. long, 35-ft. wood piles were driven vertically behind the old Wakefield sheeting on each side of the sewer to carry heavy concrete caps parallel with the sewer.

Shoulders on the lower parts of these caps support a 24-in. concrete sub-slab which is in direct contact with the crown of the sewer and provides a weight to resist the vertical pressure created by a 10-ft. hydraulic head. On the upper part of the caps is seated a heavier deck of precast reinforced-concrete slabs, 37½ ft. long, for carrying the load of the ballasted tracks, a clear space of 8 in. being provided between the two courses of slabs. This is the construction shown in section *A*, Fig. 3.

A vitrobestos and pitch filler is placed between the concrete caps and the sub-slab, so that any settlement or deflection of the track slabs will not cause loads from the tracks to be transmitted through the sub-slab onto the sewer. The 8-in. space between the two slabs would permit about an 8-in. settlement in the pile caps before any of the track load could be transmitted to the sewer. As the piles rest on solid rock, there is no liability of such a settlement, so that the design makes it impossible for any load or vibration from the track structure to reach the sewer.

At the west side of the right-of-way, where the sewer was constructed by the shield method, there is no Wakefield sheeting in place. To protect the sewer against injury during the driving of wood piles to support the structure carrying the tracks, 20-ft. steel sheetpiling was driven on a 2 to 12 batter away from the sewer, as shown in sections *B* and *C*, Fig. 3. The same general method of protection described above was used for this west section, except that the battering of the piles made it possible to use 32-ft. precast slabs to support the tracks.

With the crowning of the right-of-way the distance between base of rail and top of sewer at the west side of the right-of-way was reduced to such an extent that the sub-slab had to be made thinner at the middle and heavily reinforced, its lower sides being shaped to form a saddle resting on the brick sewer (see section *B*). Where the height of base of rail above the crown of

the sewer was such as to give sufficient distance, the bottom of the sub-slab was raised to a maximum height of 6 in. above the top of the sewer and resting on an earth cushion at the crown (see section *C*). In this manner the weight of concrete necessary in the sub-slab to produce the required pressure was correspondingly reduced by the added amount of earth left on top of the sewer.

Concrete in the pile caps and sub-slab was poured in

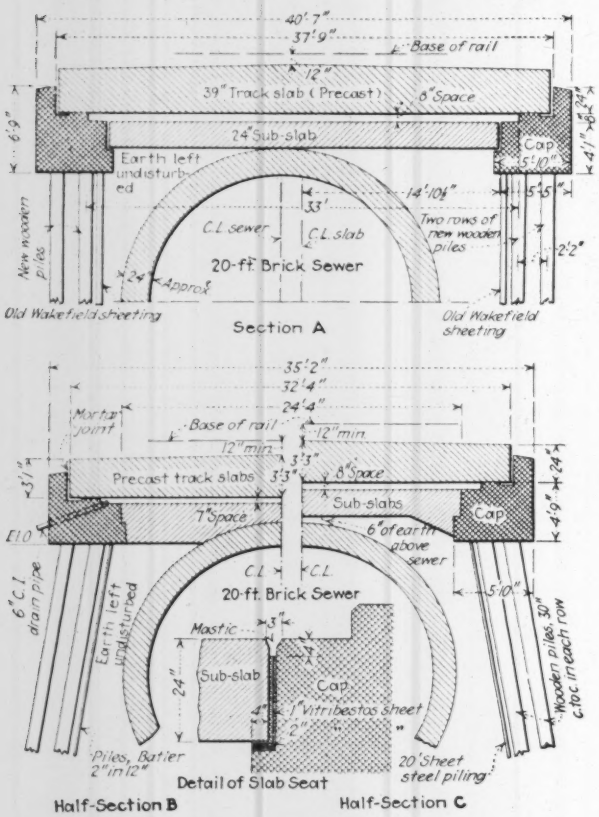


FIG. 3—SLABS CARRY TRACK AND PROVIDE REACTION FOR PRESSURE SEWER

Section A: construction where old wood sheeting was in place. Section B where no old sheeting existed; sub-slab recessed for minimum thickness. Section C: conditions similar to those of section B, but with 6 in. of earth cover left over sewer.

place in varying lengths, depending upon the space available between the various stages of track depression. The upper deck carrying the tracks is composed of precast slabs 6½ ft. wide, as used for decks of bridges over streets. These track slabs rest directly on the pile caps except for a thin layer of grout put on to form a smooth surface. The vertical joints between the track slabs and the caps are sealed with 1:2 cement mortar.

This sewer protection and roadbed drainage system are parts of the extensive Chicago terminal improvements now being made by the Illinois Central R.R. Both works were designed by the company's Chicago Terminal Improvement organization, of which D. J. Brumley is chief engineer and C. H. Mottier, engineer of design. The contractors were the Underground Construction Co. for the drainage system and siphons, and the States Corporation for the sewer protection work.

Railroads and Other Industries Compared

THAT the railroad industry has not grown or developed in proportion to other great industries in recent years is shown in a recent report of the research council of the National Transportation Institute. Figures indicating this condition are summarized in the accompanying table, which shows that with a high increase in number of persons employed there is a low increase in capital investment in railroads. The great importance of railroad transportation in the commercial development of the country, and the relation of the cost of this service to the value of service rendered is indicated by the following extract from the report:

Of the national income which was created during 1922, $4,000,000,000 was paid to the railroads for the transportation of freight. This constituted not far from 6 per cent of the total national income in 1922, and measured the burden of freight rates upon producers and consumers in that year. With the increased industrial activity of 1923 the bill will come roughly to $4,700,000,000. Freight rates had absorbed almost exactly the same percentage of the national income in 1900 and in 1910. They amounted to $1,052,000,000 in 1900, when the national income was $17,965,000,000. In 1910 they were $1,925,553,000 and the national income was $31,100,000,000. In 1917 they fell to 5.25 per cent, but by 1922 they were again at 6 per cent. This means that 6 per cent of the food and clothing which we produce, of the iron, steel and coal, of the houses which are built and of the personal services which are rendered, is devoted to the support of the people who transport the product of field, forest and mine to the point of manufacture; and who carry the products of our factories back to the consumer.

The advantage which the nation derives from the transportation function rendered by the railroads in return for freight rates is the increased production per worker and per unit of capital employed which results from the geographical division of industry. Because of transportation we are enabled to produce commodities at the points where the output per worker and per unit of machinery and equipment is the largest. Fertile valleys and auspicious climatic conditions are of little use until transportation facilities are provided to carry the products to the point of consumption. For the service thus rendered and for the advantages in production which flow from the geographical division of industry, 6 per cent of the resulting product is paid to the labor and capital engaged either directly or indirectly in transporting commodities by rail.

GROWTH OF INDUSTRIES: 1900 TO 1920

Industry	Persons Engaged—No. in 1920	Persons Engaged—Per Cent, Taking 1900 as 100	Capital In 1920 (Millions)	Capital Investment Per Cent, Taking 1900 as 100
Agriculture	10,682,944	104	77,924	381
Manufacture	10,543,599	208	44,466	495
Mining	1,055,757	170	6,955	302
Railroads	2,022,832	199	19,839	193

It is easy to forget that transportation is the function which has made possible the unprecedented productivity of modern industrial society. It is well, therefore, to state clearly just what the burden of freight rates comes to in terms of goods and services. In this manner we are able to see clearly that those who are engaged in transporting commodities by freight receive only a small portion of the additional output which is made possible by the geographical distribution of industry Transportation is an indispensable factor in our modern industrial society.

New Tunnel to Penetrate the Appenines

The sum of 100,000,000 lire will be expended in the construction of a tunnel to penetrate the Appenines in connection with the new direct railway line between Florence and Bologna. A decree confers authority upon the Minister of Finance to provide the necessary funds.

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Locomotive Cranes Set Two Completely Assembled Plate Girder Spans

IN REPLACING a pile trestle on the Pennsylvania R.R. at Plainfield, Ind., the division officials worked out a plan of operation that caused a minimum of delay to traffic. The two 85-ft. plate girder spans were completely assembled at a side track about one-half mile east of the bridge, and when assembled each span was set on a pair of car trucks. The creosoted ties, timber guard rails and the track rails for the deck were also placed on each span. When ready for movement each span weighed about 80 tons.

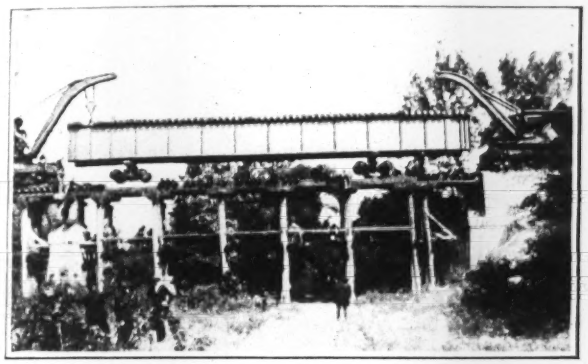


PLATE-GIRDER SPAN READY FOR PLACEMENT

Meanwhile the old trestle was made ready for the change. The concrete pier and U-abutments had been built in between the bents of the bridge some months before and the bridge seats were ready for the new girder. The span of the pile bent over the pier was cut and two small bents were framed in on top of the bridge seats as shown in the photograph. This arrangement made it possible to reduce materially the reach of the crane that would stand on the trestle in setting the first span and also made it possible to use the bridge after one span had been placed. All the bracing on the trestle that could be safely removed was taken off and some other members were cut part way through.

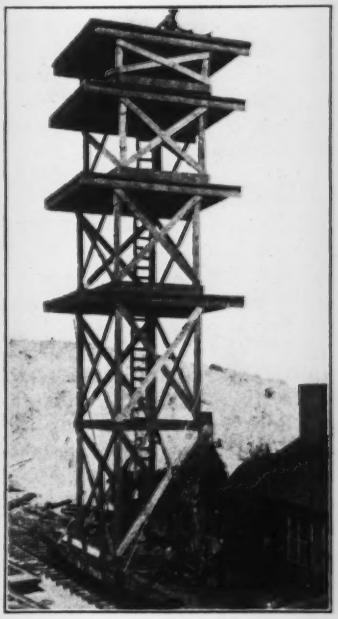
When the bridge was ready a locomotive crane was placed at each end of one span and when the lifting tackle had been arranged the cranes were run out on the bridge with the span between them. While the cranes were being blocked in position at the bridge the rails on the old deck were cut and the last spikes drawn, and as soon as the cranes had lifted the span a cable from a work train was run under one of the cranes and the rails were drawn back off the bridge. The cutting of the bents of the trestle above the clearance line for the new span was then completed and the whole top of the trestle pulled off sidewise by means of blocks and falls. When the trestle was clear the span was let down into place, the end ties set and the rails coupled. The trucks on the underside of the span were taken off by the cranes. The second span was placed in the same manner.

Photographs and details of the work herein described were furnished by *Pennsylvania News* of the Southwestern Region, Pennsylvania R.R. System.

Staging on Flatcar Saves Time in Driving Bridge Pins

RIVER conditions made it necessary that every means be employed to save time in the construction of the railroad bridge over the Colorado River recently built by the Southern Pacific Co. at Yuma, Ariz. Among the methods developed to meet this requirement was a staging mounted on a flatcar which was used to drive the pins at panel points in the top chord. The car was used between the two cranes that set the chord members and at each successive height an additional platform was placed on top of the staging as used for driving the preceding pins. Four working levels were thus mounted, one above the other.

As shown in the accompanying picture, the first platform, built to the proper level for the hip pin, was fastened rigidly to the car, well braced and then guyed with twisted wires. The car was moved out on the bridge ahead of one of the cranes and was used successively in driving the end pins in both trusses at each end of the bridge. The second platform was then added and the process repeated, the four pins of equal height in each truss being driven from each successive stage until the middle of the bridge was reached. Here the pins linking up the last three chords in each truss were near enough to the same height to make it feasible to drive them all from the top platform. The successive platform levels were about 24, 33, 41 and 46 ft. respectively, above the rail head. Using the construction shown they were found to be safe without any anchors or guys above the first platform level.

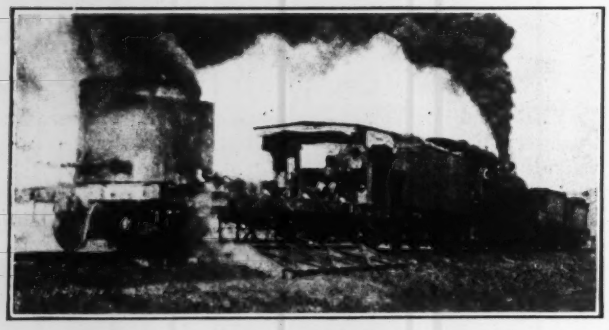


FOUR-LEVEL STAGING FOR BRIDGE BUILDING

The staging was devised by G. W. Rear, bridge engineer, Southern Pacific Co., who supervised erection of the bridge.

Superheated Steam Used to Kill Weeds

A CHEAP and effective way of killing weeds growing in the ballast of railroad tracks has been devised on the Southern Ry. System. The method is well illustrated in the accompanying photograph. The steaming boxes are 20 ft. long and are so mounted on the sides of a flatcar that they can be raised or lowered as conditions require. Steam from the locomotive used to propel the car is passed through coils in an oil-burning furnace where it is superheated before being supplied to fifteen perforated pipes in the steaming boxes through which it is sprayed on the track at a pressure



WEED KILLER IN OPERATION

of about 75 lb. per square inch, and at a temperature of from 700 to 900 deg. F. Satisfactory results are obtained at 2½ m.p.h. where weeds are thick, and at 4 m.p.h. where the weeds are small.

The cost, including work train charges, ranges from $8 to $10 per mile for each operation and as four trips a season are sufficient to keep down a dense growth of weeds the cost per season is from $32 to $40 per mile. Though this is approximately 1½ times the cost of doing the same work once a year by hand, the steaming method does not destroy the trim of the ballast section in the same way that hand weeding does.

This method of killing weeds was devised by C. G. Arthur, superintendent of the Richmond Division, Southern Railway System.

Index Cards Show Tunnel Progress

INDEX cards are used for the reports of progress on the six-mile Moffat tunnel, now being driven through the Rocky Mountains near Denver, Colo. These cards are 5 x 3 in., arranged as shown in the accompanying cut. On the reverse side is a wide column for "Remarks," followed by two narrower columns for "Meter Readings" and "Weather."

In explanation it may be noted that a water tunnel 8 x 8 ft. is being driven parallel with the main tunnel, while lateral drifts from the former tunnel will enable several headings to be worked on the latter tunnel. This great tunnel project was described in *Engineering News-Record*, Dec. 13, 1923, p. 962. R. H. Keays is chief engineer of the Moffat Tunnel Commission, Denver, Colo.; Clifford A. Betts is office engineer. The contractors are Hitchcock & Tinkler, San Francisco, Calif.

PROGRESS REPORT MOFFAT TUNNEL M-7

PORTAL

PERIOD COVERED IN REPORT _____ DATED _____ 192__

		HEADING AT STA.	DISTANCE IN	PROGRESS	ROCK FORMATION	REMARKS
WATER TUNNEL						
WORK DONE FROM CROSS CUT	MAIN HEADING GOING WEST					
STA.	MAIN HEADING GOING EAST					
WORK DONE FROM CROSS CUT	MAIN HEADING GOING WEST					
STA.	MAIN HEADING GOING EAST					
RAILROAD TUNNEL						

TUNNEL PROGRESS SHOWN BY INDEX CARDS

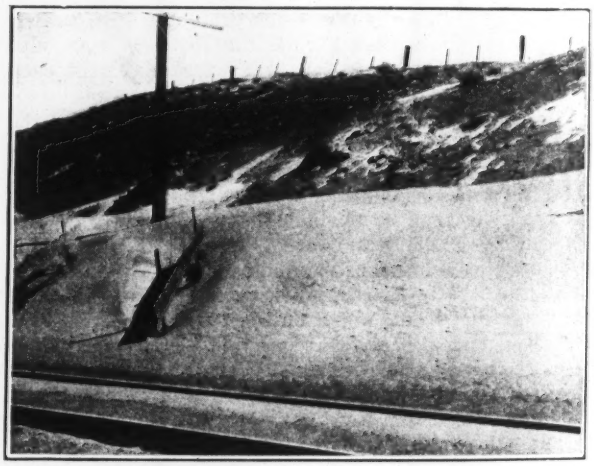
From Job and Office

Hints that Cut Cost and Time

Fences and Oil Used to Keep Sand From Drifting on Tracks

SAND DRIFTS so heavily at times in the Columbia River Valley east of The Dalles, Ore., that railroad operation there is subjected to serious interference if preventive measures are not used. The sand is brought down by Columbia River floods and is deposited here where the current runs slower. At low water great areas of sand bars are exposed from which dry sand is taken up by the winds and drifted into slowly moving dunes.

Much study was given to this question by the engineering department of the Oregon-Washington Railroad & Navigation Co. because there were times when rail-



OILED DUNES AND SAND BARRIERS

The darker areas in background are dunes over which oil has been sprayed. Drifting along the tracks is controlled by small barriers in left foreground.

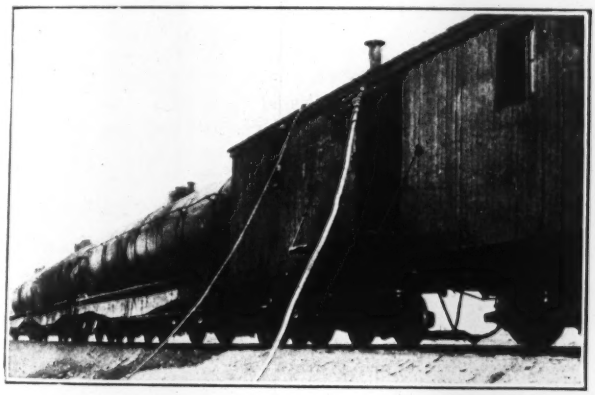
road operation was temporarily suspended because sand drifted on the tracks faster than men could remove it. In summer the prevailing direction of the winds is up the river and at various places where, on account of the topographical features of the country or curvature of the railroad, the direction of the currents is across the track, the tendency exists for dunes to build up and cause trouble. After extended study and experiment the railroad has worked out the problem to the point where sand troubles are classed as a minor incon-

From Job and Office

For Contractor and Engineer

venience. Two methods are used to keep the dunes from drifting across the tracks: the erection of sand fences or barriers and the oiling with crude petroleum of sand dunes along the right-of-way.

The barriers function on a principle similar to the ordinary snow barriers and cause the sand to drift in such a way as not to obstruct the track. When drifts have been built up by this means to a sufficient height the sand that blows over their tops will be carried across the tracks and pass on. These barriers may be set inclined or at right angles to the direction of the wind, depending upon conditions. In some cases it has been found advisable to set them almost parallel with the wind. The method used in each particular case is the result of experiment and observation at that point. The barriers are usually made in 16-ft. sections about 2 ft. wide and are set at suitable distances apart as shown in the accompanying picture. Occasionally where drifts are deep, a solid fence 8 or 10 ft. high is built parallel to the track. In some cases these fences have been found more effective if the lower boards of the fence



OIL SUPPLY AND HEATING CAR

The oil is heated by a small steam boiler and several hose crews of 2 or 3 men each are served simultaneously from the oil train.

are omitted, thereby furnishing a funnel effect and permitting the wind to carry the sand across the track at increased velocity at a lower level.

In the oiling process the ground is covered with crude petroleum which is heated in tank cars to get the desired fluidity, and is then forced under pressure through lines of hose to spray nozzles. This forms an asphaltic film about ⅛ to ¼ in. thick which prevents the sand so covered from blowing away and provides a comparatively smooth surface over which moving sand will pass without lodging or forming drifts.

The area covered and the frequency of operation vary with conditions. At some points the sand has to be oiled every year; at others, every two or three years is sufficient. Ordinarily, about 500 to 600 gal. of oil per acre are used.

In some cases it has been found good practice to oil the large dunes along the right-of-way and, in addition, to use small barriers close to the track. This is usually

SPRAYING A LARGE DUNE

Dark area at the right shows start of work.

done where the large dunes are very close—a situation in which small drifts are likely to form directly on the tracks. Protective measures may be required on only one side of the track or, especially where the alignment is nearly parallel to the direction of the prevailing winds, on both sides.

The oil is heated by a small steam boiler in a freight car. One main hose line is extended from the boiler and from this three or four lines of smaller hose are operated. There are about 12 men in a crew which covers, under favorable conditions, about ten acres per day.

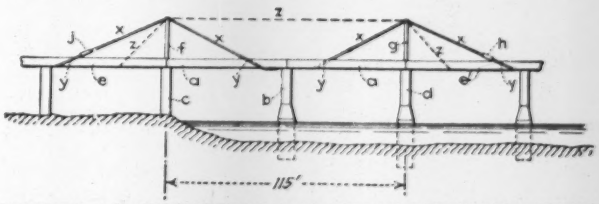
The control of this shifting sand is under the direction of H. A. Roberts, engineer, maintenance-of-way, Oregon-Washington Railroad & Navigation Co.

Temporary Trussing Supports Damaged Girders on Irish Ry. Bridge

By Major Johnstone-Taylor
Lyme, England

THE FOLLOWING method was recently employed in the repair of a plate-girder bridge on the Irish Great Southern Ry., which had been damaged by explosives during the local warfare in that country. The main girders *a* are plate girders connected by the necessary cross girders upon which are laid the railbearers and the rails at 5 ft. 3-in. gage.

Of the river piers four are of the usual cast-iron concrete-filled cylinder type. Referring to the diagram, the top of pier *b* was damaged by explosives so that one of the girders *a* was unsupported and dropped 18 in., while the other parallel to it dropped about 4 in. and came to rest upon what remained of the top of the other pier. The reason the girders did not entirely collapse was because the ends on pier *b* were free ends while



METHOD OF SUPPORTING GIRDERS WITH WIRE CABLES

those on piers *c* and *d* were fixed. Thus, the damaged girders became, in effect, cantilevers jointed to the other girders *e* and *e'* by plates on the top flanges.

The use of cribs or other supports from below being, in this instance, impracticable, the arrangement shown in the diagram was resorted to. Timber trestles *f* and *g* were erected. A continuous length of 1½-in. diam. wire rope *x*, 225 ft. long, terminates in turnbuckles *h* and *j*, timber bolsters being fixed at points *y* to prevent damage from the girder. These were fixed by angle cleats. By means of the turnbuckles the girders were brought to a level position and the damaged ends cut off by oxyacetylene torches. The new girder ends and other tackle were hoisted into position by means of a 1-in. wire rope, *z*.

The whole job was carried out quite successfully without any hitch.

Construction Progress Records and Charts: C., B. & Q. R.R.

TO ENABLE both the engineer and the contractor to visualize readily the status of the grading work on any piece of construction, the Chicago, Burlington & Quincy R.R. is using the tabular monthly record shown in the accompanying table and known as a "monthly procedure statement." A special feature is that for each work section it shows not only the yardage remaining but also the rate per month necessary to complete the excavation within the time limit of the contract. Then by comparing this rate with the progress for the previous month it is at once evident whether the work needs to be pushed more vigorously.

For example, in Section 1, in the table, the required monthly progress is 8,679 cu.yd., while the January amount was only 7,943 cu.yd., making it plain that the contractor must increase his progress. On most of the sections on this job, however, the progress is somewhat beyond the actual requirements at the time of the report. The same is true of the work as a whole, shown in the bottom line of the record. Since the equipment is recorded, the contractor can determine whether to put on an additional shovel, to replace the present machine by a larger shovel, or to ascertain why the machine on the work has not made adequate progress.

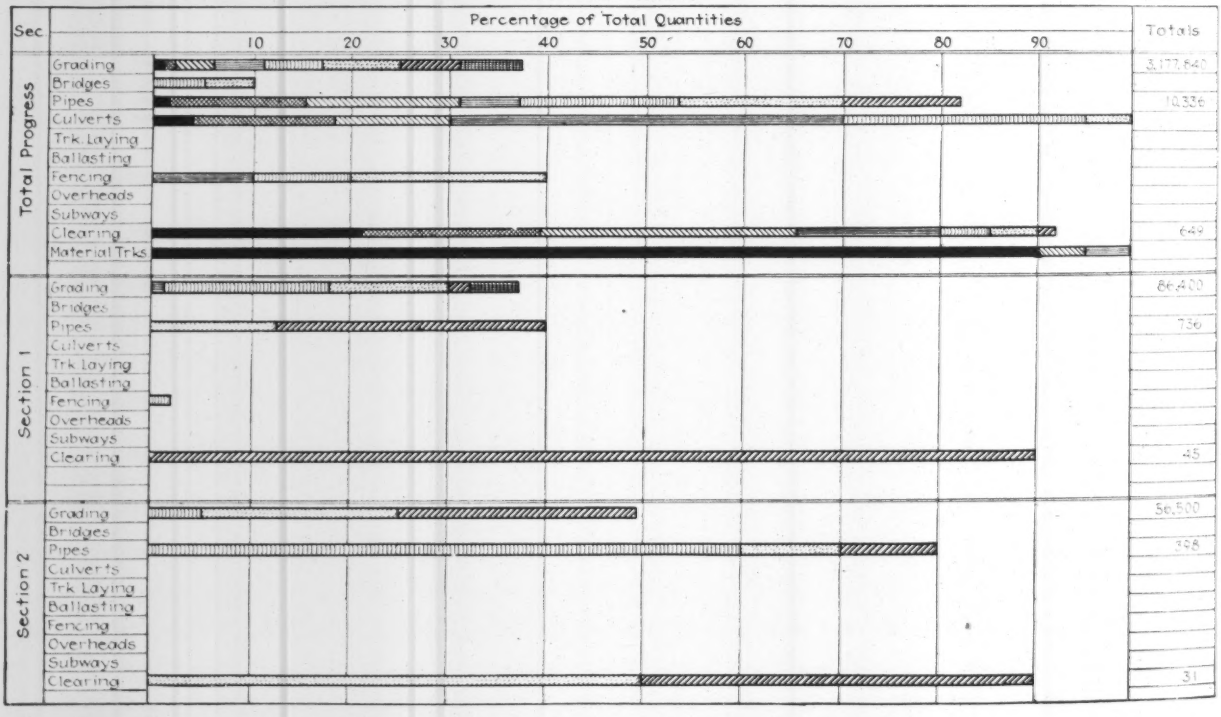
From Job and Office

Hints that Cut Cost and Time

MONTHLY PROCEDURE STATEMENT

Work Section	Total Cu.Yds. in Section	Completed to Dec. 20, 1923	Balance to be Done Dec. 20, 1923	Rate per Month to Finish Aug. 31, 1924	Equipment	January Progress
1	86,400	25,644	60,756	8,679	1—¾ yard shovel	7,943
2	56,500	21,448	28,815	5,715	1—¾ yard shovel	6,237
3	682,650	146,297	536,353	76,622	1—50-B shovel 1—70-C shovel	75,401
4	296,800	31,151	265,649	37,950	2—¾ yard shovels	32,033
5	406,200	133,060	273,140	39,020	1—1¼ yard shovel	38,419
6	99,800	33,698	66,102	9,444	1—¾ yard shovel	10,123
7	134,200	20,253	113,947	16,278	1—1¼ yard shovel	20,253
8	313,100	104,735	208,365	29,767	1—1¼ yard shovel 1—¾ yard shovel	27,834
9	352,400	128,915	223,485	31,927	1—70-C shovel 1—¾ yard shovel	39,265
10	258,100	90,033	168,067	24,010	1—70-C shovel	27,535
11	491,690	73,222	418,468	59,780	1—70-C shovel 1—¾ yard shovel	60,080
	3,177,840	803,506	2,374,334	339,192		350,303

PROGRESS CHART



PROGRESS CHART OF RAILROAD CONSTRUCTION; C., B. & Q. R.R.

From Job and Office

For Contractor and Engineer

For each section and for the entire work this record gives the total yardage, yardage completed, yardage of the past month, yardage remaining and the average monthly yardage necessary for the remainder of the work. The number and size of excavating plant is given, but not the method by which the material is being hauled away, as there is a weekly report chart which shows the numbers of engines, cars and other hauling equipment. In the final column for "remarks" it is noted that on Section 3 one of the two shovels worked one shift while the other worked two shifts. This record is kept by the assistant engineer on the work and is sent to the chief engineer's office on the twentieth of each month.

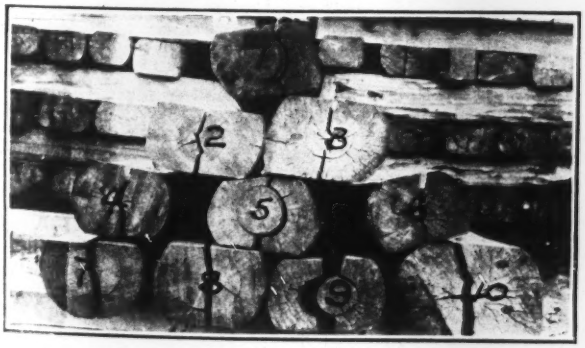
A graphic monthly progress chart is also kept, showing for each month the percentage of construction on various items of work in addition to grading. A portion of this chart, which is about 13 in. wide and drawn on section paper, is shown in the accompanying drawing. In the original however, the work done in each month is indicated by colors, and is thus more conspicuous than in the drawing. The top division of the chart represents the percentage of progress on the several items for the entire work. The other divisions give similar information for the respective work sections.

Both the tabular record for grading and the chart for general progress were devised by C. L. Persons, assistant chief engineer of the Chicago, Burlington & Quincy R.R.

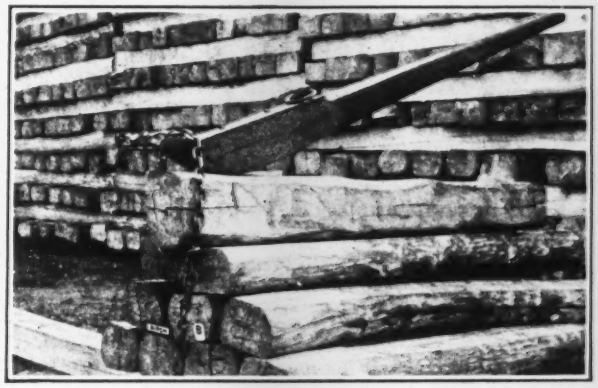
Reclaiming Checked Hardwood Ties

A RAPID and efficient way of increasing the effectiveness of the use of "S-irons" in reclaiming badly checked ties has been devised by Andrew Gibson, superintendent of the Northern Pacific Ry. timber-preservation and tie-treating plant at Brainerd, Minn., according to *Wood Preserving News*, the bulletin of the American Wood Preservers Association. Fig. 1 shows a few badly checked hardwood ties taken from the seasoning piles at the tie-treating plant, and Fig. 2 shows the same ties after the application of the "S-irons" and the method of reducing the checks before applying the irons.

Badly checked ties are segregated and piled where one man can get at the ends conveniently to apply the



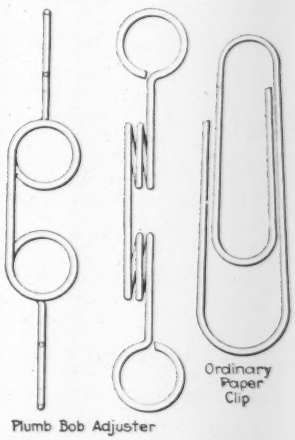
CHECKED TIES BEFORE RECLAIMING



METHOD OF RECLAIMING WITH S-IRONS

"S-irons" while others put on the chain and pinch the checks as close together as possible.

Job and Office Notes



PLUMB BOB ADJUSTER MADE FROM PAPER CLIP

An Ordinary Paper Clip can be transformed easily into an adjuster for a plumb bob, says E. K. Dupont, engineer of Stockton, Calif. Using a nail as a form and a pair of pliers as the only needed tools the clip is bent as is shown herewith. When the adjuster is made the plumb line is passed through the lower ring, then through the first loop from left to right, and through the second loop from right to left. The line is then passed through the instrument hook and brought to a tie at the upper ring. The whole adjustment can be made in a few minutes.

Accurately Locating Track Centers for bridge renewal work and proper referencing of these points is often overlooked when making the original layout for such work on the ground. It should be realized that most stakes set in the track at the site or points set in the deck of the old structure, as the case may be, will be displaced during the progress of the work. For this reason when the work is first laid out track centers should be run and the position of pier centers and the face of ballast walls carefully located on the track. The position of these points should then be marked on the rails at each side of the track by paint and by a crow-foot lightly punched into the rail base. The punch marks can be easily located and are liable to remain throughout the operation as rail is usually not changed until the new deck is put on. When the track centers have been located on the center line of the piers and abutments a set-up should be made over each point and two large hubs set well out on a line perpendicular to the center of track if possible, or at the side of the track on shore on whichever side is most suitable. The distance from the point at the center of track to the tack in these hubs should be carefully chained and recorded both on a stake at the hub and in a sketch plan of the layout. When the layout is completed set-ups should be made over the outer one of each pair of hubs and the line run out to center of track to check the setting. Once these hubs are established they can be used to give line for piers and abutments regardless of whether the track is occupied or not.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Pavement Design and Concrete Pavements

Sir—In *Engineering News-Record*, Jan. 10, 1924, p. 78, almost three and one-half pages are devoted to the subject of reinforcing concrete pavements in three carefully prepared articles by three engineers who are among the leaders in forward thinking design of portland cement highways.

These three short articles are indeed interesting in that they show again the inability of any two engineers, who specialize in concrete paving, to agree on any aspect of the subject. One engineer goes to a great deal of time, trouble and expense to develop assumptions and theories based on these assumptons, and two other engineers of equal or greater reputation calmly say, "He's all wrong." On the other hand, Major Besson, in his recent book, "City Pavements," says, "Considering all elements, and the fact that the concrete is but part of a project which eventually calls for a future wearing surface, it is believed that there is no justification for the *expense* of *reinforcing*, for contraction joints nor for so-called expansion mastic joints."

Certainly somebody is wrong. Is one man justified in spending almost 60c. per square yard for steel when another authority says there is no justification for it? Is it possible that only one of these four men profited by the experence gained in the Pittsburg road test where the unreinforced slabs seemed to give the better results? Or are we supposed to ignore the Pittsburg test because the climatic conditions differ from ours?

And it is not only in regard to reinforcement that the authorities differ. Take the subject of joints, construction, expansion and contraction. In one of our middle western states the specifications call for transverse joints at 30-ft. intervals and a construction joint longitudinally, while just across the state line transverse joints are placed only at the end of a day's run and no longitudinal joint is used. Are both right?

It is interesting to follow the progress of joint design. Engineers first discovered that concrete cracked at fairly regular intervals transversely. Not to be outdone by the inherent pecularities of the material they were working with, they designed joints to take the place of the unslightly cracks. They next discovered that the slabs cracked lengthwise so they designed a joint to take the place of this crack. Is it not logical to believe that some far-seeing engineer will come forward with a design for a joint cutting off the corners of the slabs so that the familiar "crow feet" will be regular instead of irregular? By using the same line of reasoning, if I had two pairs of pants which ripped up the seat after a few days' wear, I would be justified in buying a third pair, having them ripped in advance.

It is my opinion that this lack of unity of thought and action is caused very largely by the mushroom growth of the necessity of highway development which finds the engineering profession without enough paving men to commence to fulfill requirements. It is perfectly natural that the county engineers and state highway engineers who were confronted with spending large sums of money for hard surfaced roads, themselves without previous paving experience, should turn to concrete as a solution instead of using some pavement of proven value.

Every one is familiar with concrete. You will meet many laymen that will tell you they know all about it. It is very easy then for an engineer who has built curbs, walks, foundations, structures, etc., to feel that he knows concrete well enough to use it for paving. His inexperience causes him to pass up the many forms of black top pavement on account of their seeming complications, preferring wheelbarrow-measured aggregates to carefully heated, screened, tested and weighed materials from half a dozen bins.

It is a perfectly natural path for their thoughts to follow and they should not be censured too severely for [illegible]. They could not claim, to their county and highway commissioners, that they had had black top experience but they could claim experience with concrete. You naturally would not expect them to plead ignorance of asphaltic types of pavement and then start out on a large asphaltic paving program.

There are two points in connection with the way that a large majority of our development programs have been carried out that I wish to call to the attention of the profession and at the same time express my disapproval.

The first is the lack of progressive construction. This applies principally to the more thickly populated sections. The highways in the United States where traffic demands a dirt road today and a paved highway tomorrow can be counted on both hands. Industrial developments and conditions brought about by the war did cause this in a few isolated instances. Yet how many miles of hard surfaced roads have been built over subgrades from a month to a year old?

No pavement will give satisfactory service over such a subgrade. However, if the subgrade is properly aged most any kind of a resilient pavement would last for years. The natural sequence in constructing surfaces for a highway would be dirt, gravel, surface treatments with bituminous oils, penetration macadam, and asphaltic concrete or sheet asphalt (depending on local supply of material). The change from one type to the next higher should be made when the maintenance on one type cost more per year than the interest and sinking fund necessary to bond the next higher type. In this way long before you reach a $40,000 per mile improvement you have a subgrade that will stand any reasonable weight of traffic and will form a better base for another surface than one foot of concrete on a new subgrade.

The second point is the defenseless position assumed by so many highway engineers in rushing to the standard of concrete, an unproved pavement and at this late date of very doubtful value. It is safe to say that 90 per cent of the concrete pavement in this country is under 5 years of age and less than $\frac{1}{10}$ of 1 per cent is over 15 years of age. Have we as engineers ever accepted anything else so hurriedly and blindly as we have this mere upstart, in the matter of age, among our reputable pavements?

Helena, Mont., Jan. 21, 1924.

TROY CARMICHAEL,
City Engineer.

Butt-Welds in Tension Bars

Sir—The failure of the square reinforced-concrete tank described in your issue of Feb. 14, p. 282, while it has many lessons on what not to do in reinforced concrete, has a pointed lesson on the common practice of making butt-welds in rods under tension. The rods tying the sides of this tank together across the corners had round pieces welded to square deformed rods so that turnbuckles could be used. The rods broke at these welds.

It may not be generally known among designers, but the designer who fondly imagines he is taking care of the sectional area cut away at the root of threads in rods, by showing upset ends, is frequently getting instead a round stub of larger diameter welded onto his rod with a butt-weld. Inspectors who object to this kind of "upsetting" are met with the response: "That is our practice."

I give two quotations from my book, "Steel Designing."

P. 459—"Welds in steel, except to form loops on small rods, will not be allowed."

P. 148—"Upsets should always be made by forging up the metal to a larger diameter. They should never be made, as the practice is in some second-class shops, by welding on a stub. It would be better and safer to cut the threads on the original rod. The practice of welding on stubs may deceive an inspector or purchaser. It is very apt to weaken the rod very materially."

The stress on the rods of this tank figures out to be small. If these rods broke in the weld under a trifling stress, what safety is there in the structure where the rods are subject to high stress and are formed by welding on stubs?

EDWARD GODFREY,
Structural Engineer.

Pittsburgh. Pa.,
Feb. 16, 1924.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

The Oregon-Washington Railroad & Navigation Co., has been authorized to extend its railroad from Crane to Burns, a distance of 30 miles in Harney County, Oregon. The estimated cost of construction is $1,076,000.

Construction of an 18-Mile Branch line from Fort Collins, Colo., on the Union Pacific Ry. has been authorized by the Interstate Commerce Commission. This line is being constructed to give access to new gas and oil fields in the vicinity of Fort Collins.

The New York State Public Service Commission has directed the elimination of certain railroad crossings in Niagara Falls, New York, which will involve an outlay of about $1,200,000. One-half of the cost is to be borne by the railroad, one-quarter by the City of Niagara Falls, and one-quarter by the state.

A New Railroad in Colombia 500 km. long is projected, according to recent press reports to the effect that the necessary capital of $10,000,000 would be raised in this country. The new line will extend from Cartagena in the department of Bolivar to Medellin in the department of Antioquia.

Electrification of Marysville Yard at a cost of $2,500,000 is included in the 1924 budget of the Western Pacific Railway Co.'s construction program. This arrangement will not only make it possible to do all the switching with electric locomotives, but will also allow the Sacramento Northern Ry., a subsidiary electric road, to handle its cars in Marysville yard with its own power.

Official Advice has been given this journal that, although the plans are not finally completed and the exact character of construction not determined upon, the Baltimore & Ohio Railroad Co. expects to undertake the electrification of its lines on Staten Island in the near future. The first section to be undertaken will be the St. George to Tottenville and South Beach line of the Staten Island Rapid Transit involving an expenditure of approximately $6,000,000.

The Montreal Central Terminal Co., which was incorporated by the Dominion Parliament in 1890 to build a bridge and tunnel, or either, at Montreal, and to lay out a terminal and other works in the city, and was refused any further extension of its charter powers in 1923, the Board of Railway Commissioners having refused approval of its plans in 1921, has given notice of application to the Quebec Legislature for an act to give its company all the powers it had under the Dominion Acts, subject to the Quebec Railway Act, and to change its name to Montreal Tunnel and Terminal Co.

Steel Erection Derrick Falls

Failure of the hoisting cable of a large guyed derrick on the new Straus Building, Chicago, on Feb. 26, caused the boom to drop and fall into the street, but fortunately without doing any damage. The derrick was of steel construction, with a 123-ft. mast and a 110-ft. boom, and at the time of the accident it was handling only a light load. The cause of failure of the rope has not been determined.

Agree on Plan for Traffic Relief at Grand Central Terminal

Plans for the proposed arrangement for traffic relief around Grand Central Terminal at New York have been agreed upon by the Borough President and the officials of the railroad company. They call for the opening of the high-level roadway at the east side of the terminal known as Depew Place, the carrying of both this roadway and the one at the west side of the terminal along Vanderbilt Ave. across 45th St. and around into Park Ave. at high level and then bringing them down to the level of Park Ave. at 46th St. The approaches to these high-level roadways are to be through a large building built across the avenue at 46th. St. The plan also calls for widening the roadways in Park Ave. from 46th St. to 56th St.

Would Lend N. Y. State Credit for Crossing Elimination

Governor Smith in his message to the New York State Legislature on grade-crossing elimination recommends that the state be empowered by a constitutional amendment to loan its credit to the railroads and municipalities to finance grade-crossing elimination. He believes that with the present state of railroad and municipal finance it will be impossible for either to raise its proper share of the cost of grade-crossing elimination in the ordinary way; that if the state finances the cost in the first instance, the railroads and municipalities will be able to repay the state in annual installments of interest and sinking fund payments on the bonds.

Governor Smith also recommends that the state prepare a program of crossing elimination so that the money can be spent in a systematic way as it becomes available. For this work he would place the responsibility on the Department of Public Works for everything outside of New York City and upon the Board of Estimate and Apportionment within the city. The Department of Public Works has nine divisional highway engineers who are in touch with grade crossing conditions on their various divisions and who are well fitted to take charge of the grade-crossing elimination program.

Concrete Institute Holds Twentieth Anniversary

One Day of Convention Devoted to Developments in Concrete—Papers and Reports

In celebration of the twentieth anniversary of its founding the American Concrete Institute at its annual convention at Chicago, Feb. 25-28, devoted all of one day to a series of memorable papers upon the development of concrete. The authors of the papers, selected in each case for distinction in some special field of concrete work, traced the rise of the material from its comparative obscurity of a quarter-century ago to its present prominence in short addresses, planned as to subject and treatment, to present a composite picture of the art and science of concrete making. The cohesion of the whole treatment was enhanced by a certain degree of ceremony and the introduction of the subject and the speakers by Richard L. Humphrey, who was president of the society during its first ten years. Further, the interest of those present was gained by an excellent exhibition, in an immediately adjoining room, of models, exhibits and photographs which illustrated, in group form, the several subjects discussed by the speakers. The day closed with a well-attended banquet.

Many Speakers Heard

The speakers and their subjects were as follows: F. W. Kelly, Albany, N. Y., president, Portland Cement Association, "Cement is the Magic of Concrete"; A. N. Johnson, dean, College of Engineering, University of Maryland, "Concrete Roads"; Arthur P. Davis, consulting engineer, Washington, D. C., "Mass Concrete"; A. W. Ransome, concrete handling equipment manufacturer, San Francisco, "The Mechanical Equipment for Handling Concrete"; Albert Kahn, architect, Detroit, "Reinforced-Concrete Buildings"; A. E. Lindau, president, American Wire Fence Co., Chicago, "Concrete Bridges"; M. M. Upson, vice-president, Raymond Concrete Pile Co., New York City, "Concrete for Foundations and Waterfront Work"; R. F. Havlik, of the Loyal Order of Moose institution at Mooseheart, Ill., "Concrete Products"; John J. Earley, architectural sculptor of Washington, "Architectural Concrete"; Prof. Arthur N. Talbot of the University of Illinois, "Engineering Research" and Prof. Duff A. Abrams of the Structural Materials Laboratory, Chicago, "Making Good Concrete."

In addition to the anniversary day, three days were devoted to the regular work of the Institute. Two standard specifications, one on concrete floors and the other on concrete sewers, were adopted to be sent to letter ballot and ten tentative specifications were adopted by the meeting. These latter were

three separate specifications on concrete pavement and one each on concrete drain tile, plain concrete sewer pipe, reinforced-concrete sewer pipe, concrete sidewalk, concrete block and tile, concrete brick and concrete staves.

One evening was given over to two simultaneous meetings of open discussion, to one of which building superintendents were invited to discuss the practical problems of concrete construction as outlined in a preprinted "question box" and in the other those especially interested in concrete products, a rapidly growing phase of the Institute's work, discussed problems peculiar to that specialty. Thirteen of the committees submitted reports and ten papers were presented.

Quality Is High-Spot Topic

The high spot in the technical discussion of the convention was the repeated reference to the subject of concrete quality with particular attention to the necessity for better determination of the definite proportioning of the aggregate. Several of the papers which concentrated on this detail have been abstracted for later presentation in *Engineering News-Record*.. They included the report of a committee on Field Methods, R. L. Bertin, chairman, submitted suggestions for the production of better concrete and a paper by J. B. Hunley, engineer of bridges and structures of the Big Four Ry. on the methods used in the Sydney bridge, which methods were described in *Engineering News-Record*, Oct. 11, 1923, together with further exposition of the methods of proportioning used by the Big Four, following the suggestions made by Professor Abrams in his several bulletins. A paper by R. W. Crum, of the Iowa State Highway Commission, outlined the new practice of the Iowa State Highway Department in weighing aggregates which, while in the preliminary and experimental stage, promises to give good results. Papers by W. A. Slater describing the field test methods of results under the auspices of the Joint Committee on the Victor Talking Machine building at Camden, N. J., and by J. G. Ahlers and Stanton Walker on the methods used in co-operation between the Portland Cement Association and the New York committee of contractors in the field tests on several concrete buildings in New York City. Details of the results of all of these studies will be given in a later issue.

Practically one morning was devoted to two talks on the Japan earthquake; one by H. N. Hadley, district engineer of the Portland Cement Association, at Seattle, who went to Japan immediately after the earthquake and spent two months there studying the effects on structures in the earthquake area, and the other by Joseph F. Ruble, of the H. K. Ferguson Co., of Cleveland, who was in Japan at the time of the earthquake, superintending the construction of several buildings for his company. Both had numerous illustrations and drawings to further amplify their observations. Mr. Hadley made a very complete analysis of the behavior of structures and concluded that while a stiff frame either of steel or reinforced concrete was necessary for safety in the earthquake area, from observation it seemed that longitudinal stiffening must be something more than mere knee braces or even cross-braces, and that integral concrete stiffening walls seemed to give the best results. In general conclusion Mr. Hadley, who is a concrete man, believed that concrete structures were the most satisfactory, when properly built, and Mr. Ferguson, who is a steel man, held the same view of the steel structure. In analyzing their remarks, however, it might be noted that emphasis could well be laid on the excellent construction of either type and that if either type were properly built it would be satisfactory.

An interesting paper by J. C. Pearson and Frank L. Hitchcock of the United States Bureau of Standards, threw considerable light on the much discussed subject of admixtures to concrete. This paper, too, will be abstracted in a later issue. In general it may be said, however, that the paper is much more favorable to the use of admixtures than a number of others which have appeared in the past and indicates that in view of the experiments, properly used admixtures such as diatomaceous earth, kaolin or hydrated lime will do much to promote workability, which is a desirable aid in insuring strength. This paper was discussed by F. L. Hutchinson of the North Carolina State Highway Commission, who confirmed many of the Bureau of Standards tests. His tests were particularly favorable to celite, a diatomaceous earth mined on the California coast.

Alumina Cement Discussed

H. L. Spackman, of Philadelphia, delivered an enthusiastic endorsement of the qualities of aluminate cement. He claimed that such cement was being used in growing quantities in Europe, particularly in France, and that its quick-setting properties and high resistance to saline exposure made its advantage very great. He predicted that it would in time be as much superior to portland cement as portland is now to natural cement. In the discussion this quite optimistic view was not concurred in by P. H. Bates, of the United States Bureau of Standards, who said that the production in France, as far as his recent observation there went, was not as great as Col. Spackman indicated and that while the cement had certain useful qualities, there were other cements, such as the iron portlands, which had not been experimented with sufficiently and which promised to be as valuable for certain demands as were the aluminates.

Among the committee reports note should be taken of the further analysis of the best methods of laying out concrete plant, the continuation of the report on the behavior of concrete block in fire-wall tests, the outline of a recommended practice for the design and construction of concrete dwelling houses, a preliminary report on the various types of expansion joints for concrete work, and the reports on the deterioration of concrete in specific structures. Among the papers not already noted there was a lengthy one by F. E. Richart of the University of Illinois, presenting a method of analysis of bending in concrete columns and one by N. M. Stineman and W. F. Lockhardt, which discussed the matter of building codes in their relation to the concrete block, taking a recently enacted code in Camden, N. J. as a model.

The convention was well attended, 517 being registered. The treasurer reported the institute to be in excellent financial condition and the membership to have increased from around 400 three years ago to over 1,250 at the time of the meeting. A. E. Lindau, of the American Wire Fence Co., Chicago, was elected president for the ensuing year, E. D. Boyer, Atlas Portland Cement Co., New York, the senior director automatically becoming vice-president succeeding Mr. Lindau whose term in that office continues another year. Harvey Whipple, 1807 E. Grand Boulevard, Detroit, is secretary of the Institute.

Engineers Active in Kansas City Manager-Charter Campaign

By a popular vote of 27,398 to 16,309 electors of Kansas City, Mo., on Feb. 26, declared in favor of a council-manager type of charter and elected a board of thirteen freeholders to draw such a charter to be submitted for referendum vote within a year. The thirteen freeholders include six men of one party, five of another, and two independent, and are pledged to employ either an expert or a board of experts in connection with the framing of a charter. The freeholders include in their membership one engineer, L. R. Ash, for several years city manager of Wichita, Kan.

The movement for a new charter was initiated some months ago after a court declaration that a charter amendment under which a non-partisan water board had been created was unconstitutional. It was decided then to make a further attempt to take the local water works out of politics and with it other city affairs as well. A meeting of representatives from 192 civic organizations was called by R. E. McDonnell, of Burns & McDonnell, consulting engineers, Kansas City. A general committee of 40 was formed to promote the movement for a new charter, with H. M. Langworthy, an attorney, as chairman, and with Mr. McDonnell as vice-chairman. The conduct of the campaign was later on delegated to a small executive committee with Mr. Ash as chairman. Mr. McDonnell was made chairman of a speakers' committee.

In the election on Feb. 26 six of the sixteen wards of the city voted against the charter proposal, some by a very large majority, but the other ten were so decidedly in favor of it that it carried by more than 11,000 majority in a total vote of about 43,700. The latter, it is said, comprised only some 30 per cent of the total registration.

If the charter to be drawn by the board selected for that purpose is adopted, Kansas City will stand next to Cleveland (population 796,841) in size of cities that have adopted the council-manager plan. Next below Kansas City stand the following: Dayton, Ohio, 152,559; Grand Rapids, Mich., 137,634; Norfolk, Va., 115,777.

Project Extensions Study of Reclamation Advisers

Final Report Is Held Up Pending More Detailed Information —Marshall Is Heard

Washington Correspondence

The report of the Special Advisers on Reclamation will not be complete before April 1. This delay in the final report has been caused by a request from the Secretary of the Interior that, in addition to the general findings, specific recommendations be made for each of the projects. This has made necessary a much closer study of the individual projects than had been anticipated, as well as study of some of the proposed extensions to projects.

This study of individual projects has called for the questioning of members of Congress and others having specific knowledge of such projects. In that connection, A. P. Davis, the former director of the reclamation service, was able to give the advisers much valuable information. It was stated, however, that Mr. Davis did not discuss in any way his removal from office by Secretary Work.

Gen. R. C. Marshall, the executive official of the Associated General Contractors, appeared before the advisers to urge the greatest possible use of private contractors in carrying out construction work on reclamation projects. He declared that the use of hired labor under the direct control of governmental agencies makes for inefficiency and extravagance. The actual cost of work done in that way generally is not shown, he said, because of failure to take into the calculation overhead and other expenses.

In commenting on the policy of the Reclamation Service in doing most of its work on a force account basis, Gov. Campbell said that private contractors as a rule are not interested in bidding on reclamation work. The work is done in isolated localities and is of a special character which frequently does not pay them to install the necessary plant to carry it forward. There is a feeling among western contractors that government work is over-inspected, with the results that bids are very hard to obtain. Gen. Marshall is preparing for the committee a list of specific instances of work which he contends should have been put up for bids.

Drawbridge Turntable Fails

On Feb. 15 the Passaic River drawbridge on the Lincoln Highway, in Newark, N. J., was closed to traffic because of failure of the turntable. The lower track and the wheels of the turntable had failed progressively under service, and immediate repair was thought necessary in order to avoid possible serious trouble. Reconstruction of the turntable is expected to take a number of weeks. Five years ago the failure of a similar drawbridge turntable on the same road less than a mile away, across the Hackensack River, led to extensive repairs, described in *Engineering News Record* April 18, 1918, p. 775.

Bridge Contracts Awarded

Delaware River Bridge Contracts 11 and 12, for the construction of the Philadelphia and Camden approach piers of the Philadelphia-Camden bridge, were awarded on Feb. 25 by the Delaware River Bridge Joint Commission. Contract 11, for the Philadelphia piers, was awarded to Frederick Snare Corp., low bidder, upon a bid of $231,000. Contract 12, for the Camden piers was awarded to H. G. Ley & Co. of Philadelphia, low bidder, upon a bid of $271,862.50.

St. Louis Garbage Disposal Cost Cut in Half

Apparently as a result of a vigorous marshalling of facts and figures by the St. Louis Bureau of Municipal Research the contract rate per ton for disposing of that part of the garbage of St. Louis that is barged down the river has been reduced by a little more than one-half for the coming as compared with the current year. Some months ago the bureau presented an analysis of the cost of both garbage collection and disposal by various means at St. Louis (see *Engineering News-Record*, Feb. 21, 1924, p. 316). Subsequently the bureau presented a supplementary statement in which it claimed that during a period of breakdown in the contractor's towing equipment tow boats owned by the city were leased to the contractor on such terms as to show that the actual cost of barging the garbage down the river was some 80c. a ton, against $2.10 being paid by the city for the present year to Klein & Katz.

Early in February the city received bids for disposal of the city's garbage in excess of what is burned by the incinerator described in the article mentioned just above. The contract was awarded to the Jefferson Distributing Co. at $1.95 a ton. A representative of the bureau made public protest against the price and alleged that the work could be done at a profit at $1 a ton. A representative of the city criticised this declaration and demanded an apology, but within a few days the Board of Public Service rescinded the award of the contract at $1.95 a ton on the ground that the form of the contract was illegal.

New specifications were drawn under which some 90 tons a day were allotted to the incinerator and about 25 tons a day to hog feeders in St. Louis County. New bids were invited for a contract subject to cancellation upon ninety days' notice by the city. Considerable competition arose and the contract was finally awarded to the Jefferson Distribution Co. at $1.03 a ton, the company furnishing a bond of $40,000 to insure performance of the contract. This contract was signed before the end of February. It is stated that it will result in a saving to the city of some $50 000 a year. Under the new contract the garbage will be taken down the river some forty miles to a piggery on Ames Island, in the Mississippi. This island is said to be owned by one of the partners of Klein & Katz, mentioned above.

Random Lines

Cause for Libel Action

Sir—In the *Saturday Evening Post* for Feb. 16 is an article by Stewart Edward White entitled "Dangerous Game—The Big Four," which says:

> There remains the rhinoceros. He is the most exasperating of the lot, for he is so stupid that almost any degree of intelligence ought to be able to circumvent his thick wits; and yet, paradoxically, that very stupidity at times makes him extremely dangerous. In intelligence he is minus-zero. He is the original prehistoric pinhead. He has no ideas at all, and only a few confused impressions. One of these, which he entertains fitfully is that he is boss of creation and is privileged alone to inhabit the earth. . . .

Somewhat further along Mr. White says "the rhinoceros is an excellent engineer."

T. B. S.

* * *

Poaching

Some time ago we reported that a whilom clergyman, turned lecturer, had assumed to himself in self-conscious virtue, the name "social engineer." Evidently he did not patent the term for now comes so eminent a gentleman as Dean Roscoe Pound of the Harvard Law School, with the public statement that "the lawyer of today is a social engineer." Shinny on your own side, Roscoe, shinny on your own side!

* * *

For Open Shop Work

"A mechanical bricklayer capable of laying 1,200 to 1,500 bricks per hour has been invented by a Scotchman" says a recent issue of *The Nation's Business*. With a mortar tank, a hopper of brick, and a motor the new machine is said to lay its course of brick, come back, break joints, and even skip the openings. The machine taps each brick to settle it in the mortar.

Can it holler "more mort" and chew fine cut?

* * *

Some Odds and Ends

Hotel Engineering—A course reported to be established in New York University.

Mechanical Air Engineers — Savannah Blow Pipe Co., Savannah, Ga.

Income Engineering—Sign on broker's window in Los Angeles.

Turf Engineers—Another name for Wm. H. Tucker, golf architect.

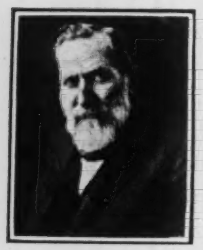
Economic Engineering—From advertisement of the Tillman Survey, Boston, Mass., who also advertise a brochure on stock market essentials.

Catalog Engineer — A "house-organ editor" advertises for a job in the Chicago *Tribune*.

Cost-Cutting Engineer—"John E. Arnold, a young business man who will run on a platform of business efficiency" for Mayor of Tulsa, Okla., according to the Tulsa *Tribune*. According to the same item he is president of the Erection Engineering Co.

Noted Rail Specialist of New York Central R.R. Dies

Dr. Plimmon H. Dudley, whose death was announced in last week's issue, was born at Freedom, Ohio, on May 21, 1843. Shortly after completing his studies at Hiram College in Ohio, he became chief engineer of the Valley R.R., then consulting engineer for the Eastern Railway Association, and in 1880 went to the New York Central R.R. as consulting engineer, a position which he held until the time of his death.



In the early seventies, Dr. Dudley became interested in improving the general track structure, which at that time was light and difficult to maintain. Many iron rails were still in use and the steel rails were of light section, weighing about 65 lb. per yard. Dr. Dudley conceived and built a recording track indicator car, about 1878, which recorded on a moving sheet of paper the general characteristics of the track and marked the location of low spots on the rail for the information of the track men. It was soon noted that a large part of the trouble was due to the light rail and in 1884 Dr. Dudley introduced on the New York Central and Hudson River R.R. the first 80-lb. rails, which had a height of 5 in. and were so designed as to increase the stiffness 66 per cent with an increase in weight of only 15 lb. per yard over the 65-lb. rails then in use on that road. In 1892 the first 6-in. rail with a weight of 100 lb. per yard was introduced.

When it became evident to Dr. Dudley that the increased wheel loads which followed the increase in weight of rail were causing an abnormal amount of rail failures, he turned his attention to a study of the composition of steel and in 1892 brought out a specification which called for about 0.6 per cent of carbon and not over 0.06 per cent of phosphorus. He also introduced the method of marking rails from different parts of the ingot with different letters. In more recent years Dr. Dudley took a very active part in the development of basic open hearth steel rails and in the study of transverse fissures.

His study of rail failures soon led him to the study of stresses and in 1896-7 he developed the stremmatograph for registering the stresses in the base of a rail under wheel load. His studies along this line led to similar studies by the American Railway Engineering Association and to the further development of many of his theories. These studies were carried on by Dr. Dudley along with his studies of general track conditions until 1907.

Dr. Dudley attended the sessions of the International Railway Congress from 1895 until the last meeting in 1910, and was reporter for the railroads of the United States at the sessions between 1900 and 1905.

Concrete Roof Collapses in Buffalo

On Feb. 28 part of the roof of a ten-story concrete building under construction in Buffalo collapsed, fortunately with no serious results except injuring one man. The structure was the Washington building, on Washington near Huron St. The roof had been concreted on Jan. 15, but the cold weather retarded the set. Construction material, including stone and tar barrels, had been placed on the roof. The shores had been removed previous to the collapse. For some days preceding the accident the top story had been heated by steam.

Sydney Harbor Bridge Let to English Bidder

The contract for the construction of the 1,650-ft. railway bridge across Sydney Harbor at Sydney, New South Wales, was let last week to Dorman, Long & Co., of Middlesbrough, England, in competition with bidders from all parts of the world. Bids had been called for on two types of structure, a cantilever and an arch, the latter being added this year after bids on the cantilever alone had been asked in 1922. The award is on the arch design, which is similar to the Hell Gate arch, though the span is larger than by more than half. The price bid is £4,250,000, or, at current rates of exchange, about $18,300,000. It covers substructure and superstructure, the latter comprising 56,300 net tons of steel. The successful bidder proposes to fabricate the work in Australia.

One Canadian bidder competed, the Canadian Bridge Co. of Walkerville, Canada.

The McClintic-Marshall Co., Pittsburgh, was the only American bidder. It submitted proposals on four designs, two of cantilever type, one arch, and one suspension bridge. A bid was also submitted by a British and Australian company, upon an American design.

Professorship of Transportation Established at Yale

The Association of Railroad Executives has established a Professorship of Transportation at Yale University in memory of the late Thomas DeWitt Cuyler, Yale '74, according to an announcement made by the university's secretary. Endowment for the chair is made up of gifts from members of the association and friends of Mr. Cuyler and amounts to $125,000.

Mr. Cuyler served as chairman of the association from 1918 until his death in 1922. He represented the railroad companies in their dealings with the U. S. Railroad Administration during federal control; in the difficulties incident to the return of the railroads to their owners; and in the important railroad wage controversies and rate questions of the last two years.

Winthrop M. Daniels, who resigned from the Interstate Commerce Commission last year to accept a professorship at Yale, will be the first to occupy the chair of Transportation.

Engineering Societies

Calendar

Annual Meetings

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Meeting, Chicago, March 11-13, 1924.

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Sixteenth Conference, Los Angeles, Calif., April 7-10, 1924.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Atlanta, Ga., April 9-12, 1924.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Meeting, San Francisco, Calif., June 11-13 1924.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, N. J., May 13-15, 1924.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, New York City, May 19-24, 1924.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 23-28, 1924.

The Brooklyn Engineers' Club at its meeting Feb. 14 had an illustrated lecture on "Transportation and Distribution of Food for Greater New York City" by W. T. Donnelly, a past president of the club.

Personal Notes

HUGH B. HOLMES is now located at 1711 First National Bank Bldg., Pittsburgh, Pa., as consulting engineer specializing in reports on properties and projects. Mr. Holmes recently was chief engineer of the Pittsburgh & West Virginia Ry.; before that, he was with Coverdale & Colpitts, consulting engineers, New York City, and previous to that chief engineer of the Kansas City, Mexico & Orient Ry.

H. E. PAWSON, for the past two years manager of the hydro-electric plant and light and power department at Sherbrook, Quebec, has been appointed manager of the engineering department of Nesbitt & Thompson Co., Montreal.

Dr. CHARLES S. ROWE, former president of Case School of Applied Science, Cleveland, Ohio, was named an honorary member of the Cleveland Engineering Society at a special meeting held Feb. 5.

HUBERT L. NAGEL has been engaged by the town of Stoughton, Mass., to design a sewer system and disposal plant. Until recently Mr. Nagel was resident engineer at Fall River, Mass., for Barbour & Dixon, engineers, Boston.

BEASLEY & STOEHR is the name of the civil engineering firm recently formed by P. W. BEASLEY and O. STOEHR and the address is 421 Chamber of Commerce Bldg., Portland, Ore. Mr. Beasley has for the past fifteen years been engaged in hydraulic engi-

neering, including irrigation, power and municipal water supply and sewage disposal. For ten years Mr. Stoehr has been in railway and highway engineering as well as in water supply work.

LAWRENCE A. DOWNS, who has been appointed president of the Central of Georgia Ry., a subsidiary of the Illinois Central Ry., was born at Greencastle, Ind., May 9, 1872, graduated from Purdue University in 1894 and entered the service of the Vandalia R.R. in 1895. In 1896 he entered the service of the Illinois Central R.R. in the engineering department. Two years later, he was appointed a roadmaster and served as such until he became assistant chief engineer, maintenance-of-way, in 1907. He was promoted to be a division superintendent in 1910, a general superintendent in 1916, assistant general manager in 1919, and in 1920 was elected vice-president and general manager of the Central of Georgia.

W. P. WILTSEE, recently appointed chief engineer of the Norfolk & Western Railway Co., was born at Cincinnati, Ohio, on May 30, 1878, and began railway work as a rodman in 1895. In 1900 he became assistant engineer of construction and maintenance on the Cincinnati, Portsmouth & Virginia Ry., now part of the Norfolk & Western, and the following year went into the office of the engineer of maintenance-of-way of the Norfolk & Western as a draftsman, becoming chief draftsman and later assistant engineer on branch line work. In 1912 he was placed in charge of extensive tidewater improvements at Norfolk, where he remained until in 1916 he became assistant engineer in the office of the chief engineer. In 1922 he became principal assistant engineer and the following year acting chief engineer.

Obituary

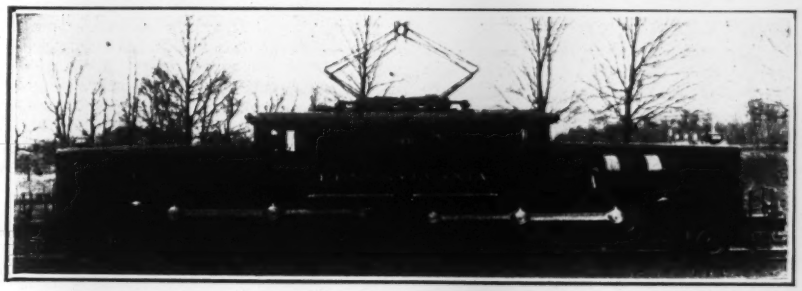
JOHN G. D. MACK, state engineer of Wisconsin and former professor in the college of engineering of the University of Wisconsin, died suddenly of a heart attack March 2 at his home in Madison. He was 57 years of age. An extended biography of Mr. Mack will be given in an early issue.

THOMAS P. ROBERTS, who retired in 1922 from twenty-five years' service as assistant United States government engineer of the Pittsburgh district, died in Pittsburgh, Pa., Feb. 19 at the age of 80 years. In 1862, after attending Penn State College, Mr. Roberts went with his father to Brazil and was engaged as engineer in building the Dom Pedro R.R. Several years later he was employed in the United States, by the Northern Pacific Railroad Co., and the Baltimore & Cumberland Railroad Co. Later, following surveys of the Ohio River and the Missouri River, he became chief engineer of the Monongahela Navigation Co. In 1897 when this company was bought by the United States government he went into government service as assistant engineer of the Pittsburgh district. He was a past-president of the Engineers Society of Western Pennsylvania.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Improved Design of Electric Locomotive to Establish Pennsylvania R. R. Standard



By T. C. Wurts

General Engineer, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

AT ITS Altoona shops the Pennsylvania R.R. is now building three powerful electric locomotives, all of the same type, one for freight service under the single-phase a.c. trolley, and the other two for passenger service, as d.c. locomotives on the New York Tunnel and Terminal Division. Each locomotive will weigh approximately 400,000 lb. and will be equipped with four single-phase, commutator type Westinghouse motors with a continuous rating on single phase of 760 hp., giving a total locomotive rating of 3,040 hp.

The locomotives have a 2-8-2 wheel arrangement. The motors are arranged two per jack shaft, and are mounted outside of, and at either end of the driving wheel base. Each jack shaft serves two pairs of drivers. The connection between the motors and the jack shaft is by means of pinions and flexible gears. The single-phase freight locomotive will have a gear ratio of 30:118 and a maximum speed of 35 mi. per hour, while the d.c. passenger locomotives will have a gear ratio of 50:98, permitting a maximum speed of 70 mi. per hour. Although two of these locomotives are being laid out for d.c. operation, while the third is to operate under an a.c. trolley, the motors and all other parts possible are being made identical.

Side rods will be utilized for the transmission of power from the jack shaft to drivers. Flexibility between the motor armature and the running gear will be provided by means of springs set in the gear center and flexible pinions in one of each pair of motors geared to their common jack shaft. These springs in the gear center and in the pinion have been especially devised by the Westinghouse Electric & Manufacturing Co. They are of the leaf type, and are inserted into their pockets without any initial tension, and are so designed that they will be active throughout the operating range of the locomotives.

A.C. Freight Locomotive—The outstanding feature of the a.c. freight locomotive is the traction motor, which has the greatest capacity of any single-phase commutator type traction motor that has ever been built in this country. The outside diameter of the frame is 76 in., while the motor is 43¾ in. long. Forced ventilation has been necessary, air being drawn instead of blown through the motors. Another novel feature of this locomotive is the use of an oil insulated, force cooled transformer. Two motor driven blower sets are provided, one for each pair of traction motors.

The control of the traction motors emphasizes simplicity. The apparatus consists only of a master controller, a reverser, the necessary unit switches for a notch-by-notch voltage increase to the normal voltage of the traction motors, preventive coils, and the minimum number of relays consistent with safety.

The locomotive capacity is as follows:

	Continuous	Hourly
Tractive effort (Lb.)	50,000	62,000
Speed (m.p.h.)	23	19.75
Maximum T. E. (Lb. at 33¼ per cent adhesion)	.....	100,000
Maximum Speed (m.p.h.)	.....	35

This means that the locomotive is capable of hauling 2,370 adjusted tons up the western slope of the Altoona grade at a speed of 24 mi. per hour.

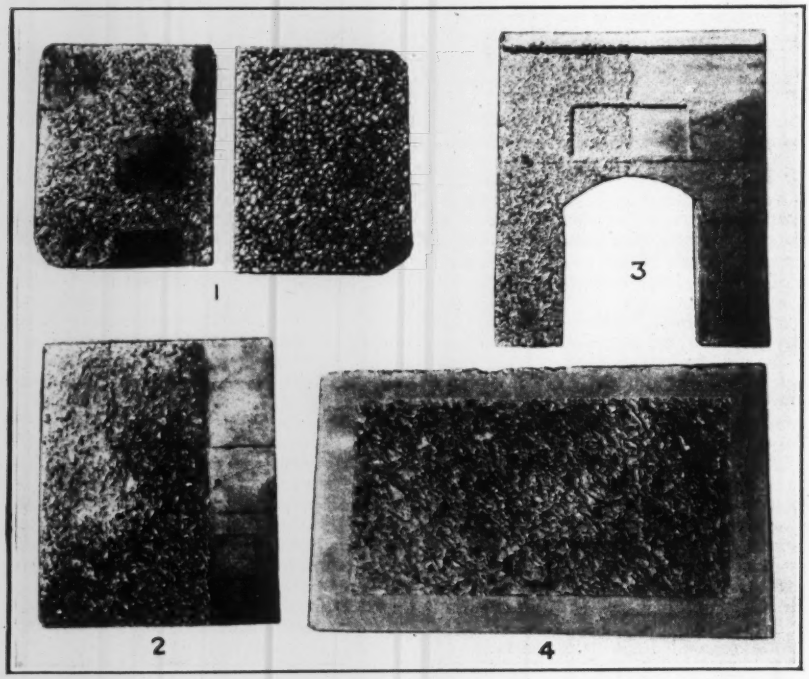
D.C. Locomotives — The passenger locomotives are of the same fundamental design as the freight locomotives just described. They are equipped with the largest unit switches in existence. These switches are of the standard Westinghouse electro-pneumatic type and have a continuous capacity of 3,000 amp.

These locomotives will be completed and placed in service early this year. If the expectations of the railroad officials are fulfilled, a tremendous advance will have been accomplished in electric locomotive design by this adaptation of one locomotive to both freight and passenger service.

Compound, Painted on Forms, Gives Exposed Aggregate Finish

By the application, with an ordinary paint brush, of a newly developed colloidal compound to forms of wood or steel for concrete construction, it is possible to produce a surface finish in which the skin coat of cement is eliminated, exposing the aggregate to give a variety of pleasing architectural effects. Former attempts to secure an exposed aggregate finish for concrete surfaces have involved the processes of grinding, tooling, or wire-brushing.

The basis of the liquid is an altered starch. It is brown in color, of the consistency of molasses, and appears to have an arresting and a repelling action on the cement with which it comes in contact. The liquid, which is patented, is the result of research by Nathan C. Johnson, of the firm of Hool & Johnson, consulting engineers, New York. It is insoluble in ordinary water, but becomes soluble in contact with the alkaline fluids of the concrete. Possessing this property, the compound, when painted on the forms, is unaffected by rain or snow.



SURFACE EFFECTS PRODUCED BY APPLYING COMPOUND TO WOOD FORMS

Tests of the compound were conducted last month at the offices of the Portland Cement Association in New York and also during the annual meeting of the American Concrete Institute in Chicago, Feb. 25-28. In the New York tests, at which a representative of *Engineering News-Record* was present, half a dozen wooden boxes were used as forms and to their inside surfaces the compound was applied in a variety of designs, in each case leaving a portion of the form surface untreated for purposes of comparison. When the forms were stripped it was found that the skin coat, as the result of the action of the compound, was in the form of a powder which was readily removed with a brush, leaving the gravel or stone aggregate projecting slightly from the body of the slab. The accompanying illustrations show types of effects produced. The compound, Mr. Johnson states, is not an acid etch and does not injure the slab beyond the depth of the skin surface. The material may be graduated in strength to eliminate the surface skin to depths of $\frac{1}{16}$ to $\frac{3}{8}$ in.

In addition to the pleasing surface effects obtainable with the compound, it has the advantage of eliminating form marks in the finished work, making possible economies in form costs by the use of rough lumber instead of matched boards. A more extensive re-use of forms also is possible when the compound is used, regardless of defacement of their surfaces. Mr. Johnson cites the actual case of a contractor who recently made a marked reduction in his estimates for form costs on a $278,000 job in anticipation of a greater re-use of forms through the medium of the colloidal compound.

Among the commercial applications of the compound are the securing of decorative effects on concrete structures of all sorts including industrial, commercial and residential buildings and bridges. Its use makes possible the paneling of pilasters, spandrel walls, and curtain walls.

Another wide field of use is in the application of the form compound to surfaces of concrete ceilings and partition walls in which the exposure of the concrete aggregate offers an excellent bond for the application of plaster.

It has been suggested also that the compound might be used during construction to give a "bite" on concrete pavements on steep grades.

In the accompanying photographs it will be noted that the compound has been effective in exposing the aggregate where it was applied to the forms, but where the forms were untreated the surface has a plain cement skin finish. The compound, it is predicted by its inventor will be effective in preventing the deterioration of concrete originating in minute surface shrinkage cracks.

Many Manufacturers Submit Bids on Road Equipment

Pennsylvania Highway Department in Market for Large Order of Maintenance Plant

Bids were opened by the Pennsylvania State Highway Department at Harrisburg, Feb. 21, for a large quantity of road-building equipment to be used for maintenance of the state's primary highway system. The equipment to be bought (see *Engineering News-Record*, Feb. 21, p. 342) includes portable air compressors and drills, concrete mixers, traction engines, road rollers, drag scrapers and plows, asphalt heating kettles, portable belt conveyors, stone crushers, pumps, sweepers, and dump wagons. Based on the prices of the low bidders the state's purchase of equipment will involve an expenditure of approximately $250,000. In the letting, prices were asked on twenty-four groups or classes of equipment.

The Low Bids

For the thirty 90-ft. displacement portable air compressors there were twelve bidders, the low unit price being $11,005. Six manufacturers submitted figures on self-rotating drills to be served by the compressors, the lowest unit price being $196. For the 34 portable belt conveyors, eight makers submitted tenders with a low price of $386. The call for five wheel-mounted jaw stone crushers drew five bids, the lowest unit price being $2,454. The state secured a low unit bid of $2,425 for five steam traction engines, to operate the crushers, on which five companies bid.

For the 13 portable gasoline-driven pumps eight firms submitted unit prices, the lowest being $258. Of seven companies bidding on the 65-gal., two-wheel-mounted asphalt heating kettles, the lowest unit price was $102. For the 3-ton gasoline road rollers the lowest unit price among three bidders was $1,350. On the larger 10-ton gasoline rollers the unit bid of $4,337 was low among seven manufacturers.

The call for 33 gasoline-engine driven, four-wheel mounted concrete mixers (10 ft. capacity, dry) drew the largest number of bidders, 23 firms offering their products, for which the low unit price was $590. For the street sprinklers $420 was the low unit bid among those of four manufacturers. For the 13-cu.ft. wheel-scrapers, eight companies competed, the low unit price being $58. On 1½-yd. dump wagons, for which nine manufacturers submitted figures, $176 was the low unit cost. Only two companies bid for the mechanical chip spreaders, the low price being $515.

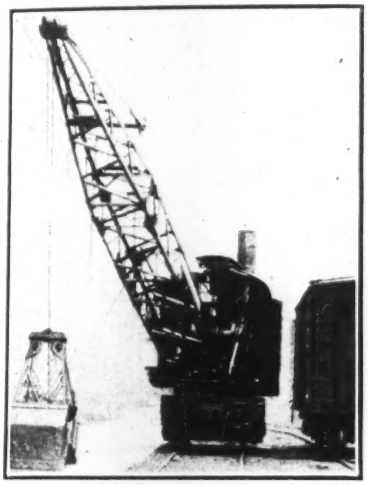
Up to the time of writing the Pennsylvania Highway Department had not announced any awards of contracts.

PEIRCE LEWIS has been appointed advertising and sales promotion manager of the Truscon Steel Co.; he will be located at the home office and plant in Youngstown, Ohio. Mr. Lewis was formerly connected with the Kawnee Manufacturing Co., and the Detroit Steel Products Co. He had previously been assistant advertising manager of the Truscon company.

Equipment and Materials

Locomotive Crane for Cleaning Railroad Ballast

A locomotive crane having special features has been built by the industrial Works, Bay City, Mich., for John F. Casey & Co., Pittsburgh, Pa., to be used



on their contract for cleaning ballast on the Pennsylvania R.R. Since this machine will operate on the main track it is necessary to avoid fouling the adjacent track and for this reason the rear end of the crane is shortened so that in any position it will be within the clearance lines of its own track. A shock-absorbing device limits the swing within the allowed clearance; springs check the movement without causing damage to the machine.

A vertical boiler of 56-in. diameter is used and is fitted with oil-burning equipment, as the arrangement left no room for a fireman. Nor was there room to place the usual large water tank, so several small tanks having an aggregate capacity of 500 gal. are mounted at convenient points. In operation the crane handles a grab bucket which picks up ballast alongside the track and dumps it upon a screen mounted on a car ahead of the machine. This method of working was described in *Engineering News-Record*, July 26, 1923, p. 149.

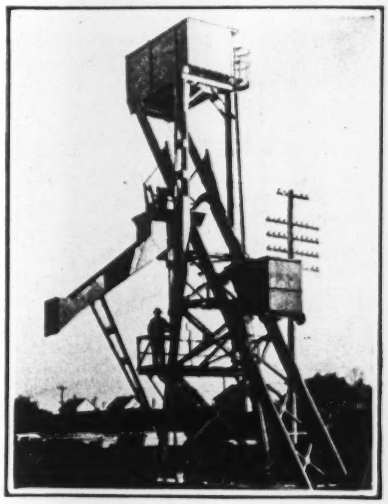
New Crawler-Tread Loader

Two new features are embodied in the latest model of portable loader designed by the Link Belt Co., Chicago. The first is a crawler-tread mounting and the second the use of solid cast steel construction for the lower base. The latter feature, it is claimed, eliminates numerous rivet and bolt connections and increases durability and rigidity. The base, which carries the loading mechanism, is pivoted in a manner similar to that employed by large locomotive cranes.

The loader is known as the Grizzly. Its capacity, according to the manufacturer, is 40 cu.ft. per minute of 1½-in. crushed stone, or 45 cu.ft. per minute of bituminous coal. The loader is equipped with swiveling mechanism enabling it to cut a path 20 ft. wide through a pile of material. Tread shoes of the crawlers are of alloy heat-treated steel, cast in one piece, and are attached by a patented design which minimizes clogging.

Combined Railway Coal and Ash Handling Plant

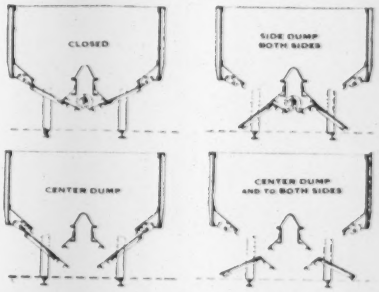
For coaling stations of the smaller class a plant which will deliver coal to locomotives and also automatically handle the cinders which are dumped from the engines is one of the latest types of coal-handling equipment brought out by the Roberts & Schaefer Co., Chicago. The tower, composed of one upright and one inclined bent, stands between two tracks, each of which has a track hopper. A short Y, or forked track, diverges from the



bucket track on the inclined bent of the tower and passes under each hopper. A drop-bottom coal car on one track delivers its contents into a concrete hopper 12 ft. long, of ample capacity for one carload. The 2-ton bucket runs under the hopper on the inclined track of the Y, trips a gate in the bottom of the hopper and receives its charge. As the car starts forward it closes the gate and is then hauled up the incline to dump into the upper end of the spout which is swung round to deliver the coal to a locomotive standing beside the tower. The other track hopper, 10 ft. long, is of cast iron and will hold the charge of cinders dumped from the largest engine. A switch diverts the bucket under this hopper and after the ashes are sprayed a track lever is thrown to open the hopper gate and charge the bucket. The water drains from the hopper, so that only the wet ashes are handled. With the spout swung round to the other track the bucket delivers its load to an empty coal car for removal. A cable hoist with 25 hp. motor is mounted on the top of the tower, and all movements are controlled from a platform, giving the operator a good view of the work.

Selective Track Ballasting Car

A large-capacity car for railway ballasting which has been brought out by the Rodger Ballast Car Co., Chicago, is termed a "selective" car, since it will deliver the ballast between or outside the rails in a variety of combinations as conditions may require. Thus



the car can distribute all the ballast on one or both sides or in the middle, or it can distribute it in two or three ways simultaneously. This flexibility of operation is effected by the various positions of hinged doors in the hopper bottom. Some of these positions are shown herewith. The car is of steel construction, with sloping ends and a longitudinal hopper bottom divided by a central ridge. The doors are operated by hand levers on each side of the car, within easy reach of men standing on the track. In service, a ballasting train of these cars has at its rear end a car equipped with an adjustable plow which throws out excess ballast for the middle and leaves the track clear of obstructions.

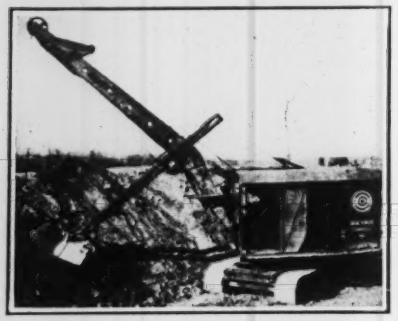
Flood-Light for Excavators

A spring suspension mounting for flood-light projectors when used on excavating machines has been brought out by the General Electric Co. and is shown herewith carrying the L-3 type of projector. With this form of attachment for projectors on the booms of dredges, steam shovels and similar machines, the springs absorb much of the vibration that would otherwise tend to shorten the life of the incandescent lamp and damage the reflector. Another feature is the solid glass reflector in place of the usual sectional reflector used on standard projectors. This construction increases the life of the reflector, as there are no sections of glass to become loosened from sudden shocks that the springs cannot absorb.

The spring suspension mounting is similar to that used with headlights for mine locomotives, providing protection to the lamps and reflectors under severe service due to rough track. Any type of projector can be mounted on the spring suspension, but it is stated that in general the L-3 type, as here shown, will meet most requirements of illumination with a 500-watt lamp.

Equip ¾-yd. Power Shovel With Full Diesel Engine

With the object of reducing to a minimum the cost of fuel for power the Bucyrus Co., South Milwaukee, Wis., announces the equipment of its ¾-yd. revolving shovel and dragline with a



full Diesel engine, a three-cylinder, 45-hp. mechanical injection machine built especially for this service. The same type of engine had been introduced about a year and a half ago on the company's larger 1-yd. shovel. The cost of oil for fuel, the manufacturer states, is only from one-third to one-quarter that of gasoline, the average consumption for the ¾-yd. shovel being estimated at from 1½ to 2 gal. of fuel oil per hour.

The shovel on which this equipment is used is known as the 20-B and is a rope thrust machine, all of the motions of the dipper being controlled by a small drum, mounted under the boom, which is turned in either direction by ropes from the main machinery.

This model of machine on crawler treads is supplied as a shovel with standard, high lift, or extra high lift boom, as a dragline excavator, as a clamshell excavator with a 35- or a 42-ft. boom or with crane equipment.

Publications from the Construction Industry

Construction—T. A. GILLESPIE CO., New York, presents in a 106-p. bound volume photographs and brief descriptive notes of the structures of various types it has built under contract during a period of 33 years. Many of the projects illustrated are steel pipe lines, including the 48-in. conduit for the East Jersey Water Co. built in 1891. In addition to its waterworks and pipe-line contracts, the company has engaged in extensive railroad and tunnel construction, hydro-electric development, river, harbor and canal improvements, bridges and sewers.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Value of 1923 Excavation Contracts Highest In Six Years

Engineering News-Record statistics covering excavation, irrigation and drainage awards of $25,000 and over for the years 1922 and 1923 show that the trend of this type of construction does not follow regular curves. The peaks occur in most of the sections during the warm months of the year. Another feature shown is that while the number of 1923 awards has not increased over that of 1922, the size of the average contract was enlarged as indicated by the money value.

During the year 1923, New England did not grant any awards for excavations and drainage and the South fell below the 1922 record.

The sharp peaks on the charts are indicative of large contracts awarded and show that this type of work is confined to seasonable parts of the year and is not of a steady progressive nature.

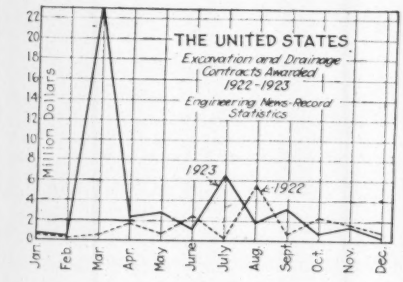
In 1922, there were 145 awards totaling $19,551,000 with an average value of $134,835 compared with 141 contracts of 1923 valued at $51,991,000 with an average value of $368,730 per contract.

According to geographic sections, the situation for this work during the two years compared has been as follows:

	1922		1923	
	No.	Value	No.	Value
New England	2	$118,000		
Mid. Atlantic	10	918,000	9	$7,278,000
Southern	21	9,093,000	18	3,327,000
Mid. West	26	1,813,000	26	2,558,000
West of Miss.	62	4,477,000	58	8,119,000
Western	24	3,132,000	30	30,709,000
Total	145	$19,551,000	141	$51,991,000

The total value of awards for excavation and drainage for 1923 places this year in the lead of the six preceding years:

1917	$25,314,000	1920	$16,219,000
1918	20,371,000	1921	19,181,000
1919	14,710,000	1922	19,551,000
1923	$51,991,000		


THE UNITED STATES
Excavation and Drainage Contracts Awarded 1922-1923
Engineering News-Record Statistics
Million Dollars
1923
1922
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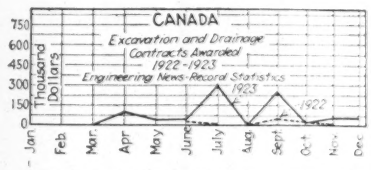
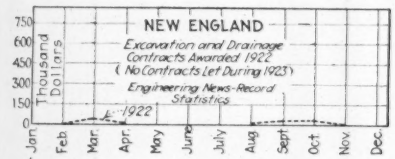
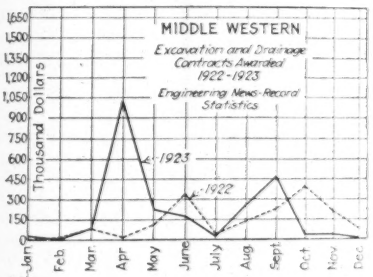
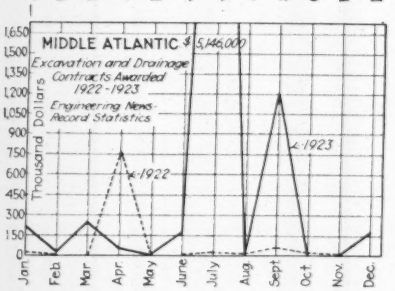
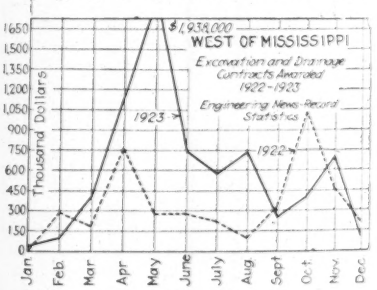
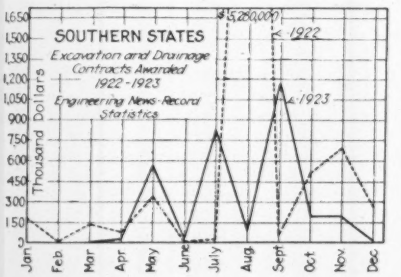


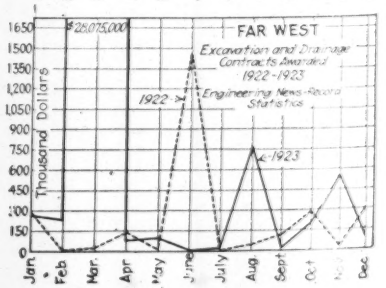

NEW ENGLAND
Excavation and Drainage Contracts Awarded 1922
(No Contracts Let During 1923)
Engineering News-Record Statistics
Thousand Dollars
1922
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec











February Contracts 33 Per Cent Heavier Than For Same Month Last Year

Gain Over Preceding Month Due Mostly to Big Excavation Projects, Streets and Roads

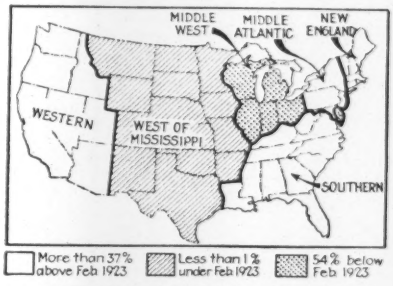
Contracts awarded on large engineering construction projects during February totaled $165,046,000, a gain of 33 per cent compared with the corresponding month in 1923. The February total ($165,046,000) taken from four issues of *Engineering News-Record* during that month, also shows a gain compared with $164,722,000 in the five January issues.

Minimum costs observed in the Construction News section on each class of construction are as follows: Waterworks, $15,000; other public works, $25,000; industrial construction, $40,000; and commercial buildings, $150,000.

The Greatest gains in money value of contracts let occurred in streets and roads, excavations, drainage and irrigation projects, and unclassified jobs such as piers, foundations, light and power systems and grain elevators.

Among the large projects awarded during February were the following: An apartment hotel, New York, N. Y. $18,000,000; section of Welland Canal, St. Catharines, Ont., $10,528,215; power plant, Long Beach, Calif., $8,000,000; 205 mi. of railway, Florida, $4,000,000; hotel, Long Beach, Calif., $2,500,000 and an office building, New York, N. Y., $2,000,000.

In the accompanying illustration, February is compared with the corresponding period in 1923, in money value of contracts let.



WHERE FEBRUARY AWARDS WERE HEAVIER THAN YEAR AGO

Missouri River Sand at Twenty Cents Per Ton

The Missouri State Highway Department has contracted with a Nebraska firm to deliver 100,000 tons of Missouri River sand to points near Kansas City, Mo., at 20c. per ton. At present the department is paying 75c. to $1 per ton for sand. It is estimated that the new contract will save the state $45,000 to $50,000.

Engineering News-Record Construction Cost Index Number

March, 1924	224.70
February, 1924	220.30
March, 1923	205.25
Peak, June, 1920	273.80
1913	100.00

Jan., 1923	191.70	Aug.	221.50
Feb.	197.40	Sept.	221.50
Mar.	205.25	Oct.	220.30
Apr.	213.50	Nov.	220.90
May	216.70	Dec.	217.30
June	220.70	Jan., 1924	217.90
July	222.10		

Engineering News-Record's Construction Cost Index Number gained 4.4 points since last month, owing to advances in lumber and labor costs. The average rate for common labor is 55c. per hr., against 54c., which rate remained in effect from June 1, 1923, to Mar. 1, 1924. Thus, general construction cost is 9 per cent higher than one year ago and 18 per cent under the peak; it is 124 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Monthly

February, 1924	(*4 issues of E. N.-R.*)	128
January, 1924	(*5 issues of E. N.-R.*)	130
February, 1923	(*4 issues of E. N.-R.*)	105

Yearly

1923	(entire year)	135
1922	(entire year)	130
1921	(entire year)	88
1920	(entire year)	91
1919	(entire year)	91
1913	(entire year)	100

Engineering News-Record's Construction Volume Index Number is 128 for the month of February, and 135 for the whole of 1923, as against 100 for 1913. This means that the actual volume of construction in 1923 (not the mere money-value of the contracts let that year) is 35 per cent above the volume of construction for 1913. Our monthly volume number, 128 for February, 1924, is really the increment of construction, and indicates the rate at which contracts are being let as compared with 1913 awards.

VALUE OF CONTRACTS LET IN THE UNITED STATES AND CANADA, FEBRUARY, 1924

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Western	United States	Canada	Total
Waterworks	.....	$479,000	$322,000	$923,000	$823,000	$1,210,000	$3,757,000	$530,000	$4,287,000
Sewers	.....	1,386,000	195,000	889,000	596,000	83,000	3,149,000	161,000	3,310,000
Bridges	.....	58,000	379,000	174,000	767,000	229,000	1,607,000	181,000	1,788,000
Excavation, drainage, irrigation	.....	20,000	.....	.....	354,000	324,000	698,000	10,528,000	11,226,000
Streets and roads	.....	2,433,000	7,089,000	1,696,000	4,603,000	3,301,000	19,122,000	92,000	19,214,000
Industrial works	$1,375,000	5,345,000	1,000,000	4,020,000	1,474,000	10,953,000	24,167,000	.....	24,167,000
Buildings	3,511,000	48,904,000	3,369,000	8,591,000	8,977,000	9,140,000	82,492,000	276,000	82,768,000
Federal Government	.....	22,000	2,126,000	119,000	65,000	91,000	2,423,000	.....	2,423,000
Unclassified	.....	2,753,000	4,860,000	750,000	3,631,000	553,000	12,547,000	3,136,000	15,863,000
Total	$4,886,000	$61,400,000	$19,340,000	$17,162,000	$21,290,000	$25,884,000	$149,962,000	$15,084,000	$165,046,000

Labor Rates and Conditions Throughout the Country

A slight general decrease in employment is reported by the U. S. Bureau of Labor Statistics. This of course involves commensurate reductions in pay-roll totals and per capita earnings —a condition the reverse of that of one year ago.

The cost of living has decreased slightly since December, 1923, particularly in farm products, foods and fuel. Substantial advances, however, have occurred in the cost of clothing, and a nation wide survey conducted by the National Industrial Conference Board shows that rents of low and medium priced houses of four or five rooms average 80 per cent above the pre-war level and 8 per cent higher than a year ago.

Despite the reduction in employment and living costs, the average rate paid common laborers (pick and shovel men) in construction operations advanced to 55c. from 54c. per hr. for the entire country. This marks the first change since July, 1923, according to *Engineering News-Record* figures. Local conditions follow:

Baltimore — Plenty of mechanics, especially carpenters, structural iron workers and common laborers.

Dallas—Bricklayers, carpenters and hodcarriers in demand. Slight surplus

CURRENT BUILDING TRADES WAGE RATES PER HOUR

(Higher rates indicated by +, decreases by —)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.12½	$0.70	$0.70	$0.50	.....	$0.75	$0.30@.40
Baltimore	1.50	.90@1.00	1.00@1.12½	1.00	$0.65	1.12½	.40
Birmingham	1.00	1.00	.50@1.00	.30@.40	.....	1.00	.30@.40
Boston	1.25	1.00@1.10	1.25@1.35	.82½	1.05	1.12½	.40@.75
Cincinnati	1.50	1.15	1.15	.90	1.15	1.15	.53½
Chicago	1.25	1.15	1.00@1.25	.88¾	1.10	1.25	.52½
Cleveland	1.40	1.25	1.25	.87½	1.00	1.10	.87½
Dallas	1.50	1.00	1.00	+.40@.75	.87½	1.00	.30@.50
Denver	1.37½@1.50	1.12½	1.12½@1.18¾	.75@.81¼	1.00	1.15⅝	.35@.55
Detroit	1.12½	.80	.80@.90	.50@.60	1.00	.60@.80	.50
Kansas City	1.37½	1.12½	1.00@1.25	—.87½	1.00	1.00	+.35@.75
Los Angeles	1.25	.100	1.00	.62½	.....	1.00	1.50
Minneapolis	1.12½	.87½	—.87½	.71½	.....	.87½	.40@.45
Montreal	.90	.65	.50	.35	.50	.65	— .25
New Orleans	1.25	.90	1.00	.65	.80	1.00	.35@.40
New York	1.50	1.31¼	1.50	1.00	1.00	1.25	.62½@.75
Philadelphia	1.50	1.12½	1.02½@1.13½	.70@1.00	1.00	1.10@1.12½	.45@.50
Pittsburgh	1.40	1.20	1.12½	1.00	.....	1.25	.70
St. Louis	1.75	+1.50@1.60	+1.50@1.67½	1.15@1.25	1.25	1.25@1.50	+.45@1.25
San Francisco	1.25	1.00	1.00	.81¼	1.00	1.12½	.50@.55
Seattle	1.25	1.00	1.00@1.12½	.93¾	1.00@1.12½	1.12½	.62½

of common laborers, as is usual at this season.

Kansas City—Plenty of men in all building trades.

Cincinnati—Present wage schedule to hold until Jan. 24, 1925. Labor in good demand.

Los Angeles—Employers opposing wage demands of 6,725 building workers. Materials dealers expect another big construction year.

Montreal—Ample supply of building trades mechanics.

New Orleans—Labor supply adequate to meet all demands; conditions normal.

Pittsburgh—Enough building trades mechanics. Possible wage adjustments during March.

St. Louis—Lathers have accepted $12 per day instead of $15, demanded. Wage advances for carpenters, hoisting engineers, hodcarriers, and common laborers effective March 1. Structural ironworkers demand base pay of $1.50 per hr., effective April 1. Building laborers demand increase of 20c. per hr., making top rate $1.25 per hr. for stone masons' laborers. Negro hodcarriers have signed a new scale of $1.25 per hr., against $1.20, demanded.

San Francisco—Small amount of unemployment in building trades. The 1923 wage schedule is still in effect.

New York—Thirty-nine of the forty-one crafts belonging to the Building Trades Council have signed contracts with the employers covering a period of two years. The two remaining unions negotiating for a settlement of their demands for wage adjustments are the composition roofers and waterproofers, and the stone cutters.

Monthly Prices of Construction Materials

Ups and Downs of the Market

Pig Iron—No. 2 foundry iron firm at $23@$24 per ton, Birmingham, despite recent easing up in demand. Attention of buyers turned toward foreign iron. Present price level considerably below year ago. Small reserve stocks of pig iron available.

Railway Supplies—Small demand for light rails continues; minimum quotation at Pittsburgh mill $40, against $43 per ton one month ago. Railroad buying confined mostly to steel plates for car and locomotive requirements.

Pipe—Standard steel and wrought pipe demand active; prices firm at present levels. Improvement in market for lapweld pipe. Prices of sewer pipe and c.-i. pipe tending upward.

Road and Paving Materials—Mexican bulk asphalt up $1 per ton at Philadelphia; abrupt rise also reported in Atlanta, due to drop in imports. Slight declines in domestic, however, reported in Minneapolis and St. Louis, despite decrease in crude oil production in the United States. Slight seasonable depression in road oils' prices in New York and St. Louis. Paving stone and wood block prices unchanged in twelve out of fifteen cities reporting regularly to *Engineering News-Record*.

Sand, Gravel and Crushed Stone—Gravel, ¾-in., down 5c. per ton in St. Louis during month; rise, however, reported in Dallas, due to local labor and transportation conditions. Slight drop in price of sand in Atlanta. Crushed stone declined 5c. per ton in Cincinnati during month.

Lime—Aside from rise of $2.40 per ton on hydrated and 35c. per bbl. on lump finishing lime in Kansas City, no other price changes occurred in nineteen cities reporting.

Cement—General tendency upward, Reduction of 16c., however, reported in Los Angeles and 10c. per bbl. in Kansas City, during month.

Steel—Steel plate market stronger in tone; fair demand for railroad material and ship plates; price steady at $2.50 per 100 lb., Pittsburgh. Buying of steel shapes more active; most quotations at $2.50 per 100 lb., Pittsburgh, with exceptional tonnages reported at $2.40. Bars firm at $2.40. Steel sheets and tin plate leading all other steel items in volume of orders placed.

Brick and Hollow Tile—Prices firm at present levels throughout the entire country. Advance of $1 per M. on common brick reported in Montreal.

Lumber—Production and shipments slower despite increasing demand. Pine stocks low, owing to heavy rains; price trend has been steadily upward since Jan. 1, with the exception of short-leaf timbers, special cuttings and railroad stock. Long-leaf yellow pine timbers rose $1 in Kansas City and St. Louis and $2 in Atlanta during month; New Orleans, however, reports decline of $2 and Philadelphia, $1 per M. ft. b.m. Douglas fir dropped $1 per M. ft. in Minneapolis and Denver. No changes in hemlock and spruce.

Explosives—Aside from a slight advance in Kansas City on 40 and 60 per cent gelatin dynamite, and an equally slight decline in Cincinnati, no other changes occurred.

Scrap—Iron and steel scrap market reflects the present easier price position of pig iron. No reaction, however, has occurred in heavy melting steel since the advance of a month ago.

Lead and Linseed Oil—General price level of raw linseed oil about 2c. per gal. above a month ago, owing to scarcity in flax market. Higher pig lead prices reflected in advance of 50c. per 100 lb. in white lead between Feb. 21 and Feb. 28. Red lead also higher.

Price advances since last month are indicated by heavy type; declines by *italics*

PIG IRON—Per Gross Ton—Quotations compiled by The Matthew Addy Co.:

	Mar. 6	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	$25.05	$29.05
Northern Basic	24.00	29.77
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	24.00	30.27
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	28.00	33.44
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	23@24	25.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	24.25	30.14
Virginia No. 2 (silicon 2.25 @ 2.75)	28.17	33.17
Basic	24.00	28.50
Gray Forge	24.00	29.00
CHICAGO		
No. 2 Foundry Local (silicon 1.75 @ 2.25)	24.50	30.00
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	27.00	31.01
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	25.77	28.50
Basic	25.77	28.50
Bessemer	26.77	29.27

SCRAP—The prices following are per gross ton paid to dealers and producers f.o.b. New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$16.00	$11.50	16@16.50
Stove plate	13.00	12.00	16.00
No. 1 machinery cast	18.00	16.50	19.50@20
Machine shop turnings	9.00	4.00	12.50@13.50
Cast borings	10.00	5.50	14.00
Railroad malleable	16.00	12.50	21.00
Re-rolling rails	14.00	13.00	21.50@22
Re-laying rails		30.00	28.00@31
Heavy melting steel	14.00	16.00	.....

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	Mar. 6	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	.....	$43.00	$46.00
Standard openhearth rails	43.00	43.00	$43.00	43.00	46.00
Light rails, 8 to 10 lb.	40@43	43@45	2.00*	43.00	2.55*
Light rails, 12 to 14 lb.	40@43	43@45	2.00*	43.00	2.45*
Light rails, 25 to 45 lb.	40@43	43@45	2.00*	43.00	2.35*
Rerolled Rails	37@40	28@30	.....	.....	2.10*

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	$1.70	$1.90
Chicago, Hardwood and Red Oak	1.35@1.45	1.50@1.70
Chicago....Empty Cell Creosoting (add'l)	.50	.60
San Francisco..... Green Douglas Fir	.84	1.14
San Francisco, Empty Cell Creosoted, Douglas Fir	1.70	2.25
St. Louis, White Oak	1.30	1.60
St. Louis (creosoted) (zinc treated)	1.70	2.05
St. Louis, Red Oak, plain	1.20	1.50
St. Louis, Sap pine-cypress	1.05	1.35

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Mar. 6	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ½-in. and larger	$3.05@3.15	$2.90	$3.00	$3.85	$4.70	$3.72
Track bolts	4.00@4.25	3.85@4.50	4.00	4.90	5.95	4.57
Standard section angle bars	2.75	2.75	2.75	3.45	4.00	3.20

PIPE

WROUGHT PIPE—The following mill discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1¼	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1¼	30	14
2 to 3	61	50½			

LAP WELD EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	48%	50%	49%
2½ to 6 in. lap welded	44%	47%	46%
	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	34%	37%	36%
2½ to 6 in. lap welded	30%	34%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4%; class A, plus 23%. Cast iron, standard sizes, 34% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham Mill	Pittsburgh	New York Mar. 6	New York One Year Ago
4 in.	$53.00	$60 20@62.20	$67.10@68.60	$61.00
6 in. and over	49.00	56.20@58.20	61.60@63.60	56.50

	Chicago	St. Louis	San Francisco
4 in.	$60.20@64.20	$58.60	$64.00
6 in. and over	57.20@60.20	54.60	60.00

Gas pipe and Class "A," $5 per ton extra.

CLAY DRAIN TILE—The following prices are per 1000 lin.ft.:

	New York					
Size, In.	Mar. 6	One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$45.00	$45.00	$50.00	$62.50	.....	$73.00
4	55.00	55.00	50.00	75.00	$76.50	83.00
5	80.00	80.00	.....	100.00	97.75	108.00
6	105.00	105.00	85.00	125.00	127.50	133.00
8	170.00	170.00	195.00	187.50	212.50	199.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	.....	$0.105	.....	.....	$0.15	$0.12	.....
4	.....	.105	$0.11	$0.1175	.15	.15	$0.15
5	.....	.1575	.1375	.....	.23	.18	.18
6	$0.24	.1575	.165	.1645	.23	.21	.21
8	.38	.245	.26	.26	.35	.30	.325
10	.57	.3675	.338	.364	.53	.42	.476
12	.72	.4725	.442	.468	.68	.54	.612
15	1.13†	.63	.65	.78†	.90	.90	.884
18	1.65†	.875	.85	1.092†	1.25	1.32	1.153
20	1.98†	1.05	1.125	.....	1.50	.....	.....
22	2.64†	1.40	1.375	1.456†	2.00	.....	1.564
24	2.97†	1.575	1.625	1.872†	2.25	2.16	2.04
27	4.81†	2.795	.....	2.95†	4.69†	3.00	3.34
30	5.33†	3.096	.....	3.65†	5.94†	3.60	4.06
33	6.93†	4.14	.....	4.45†	6.88†	.....	4.99
36	7.91†	4.715	.....	4.80†	7.50†	.....	5.42

	3	5	8	12	24	36
Boston	$0.129	$0.198	$0.305	$0.595	$1.99†	$5.97†
Minneapolis	.....	.....	.40	.72	2.55†	5.66†
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.13	.....	.36	.72†	2.60†	.....
Los Angeles	.13	.165	.275	.47‡	1.65	.....
New Orleans	.145*	.168*	.28	.476	1.182	.....
Cincinnati	.111	.1665	.259	.4995	1.665	4.92†
Atlanta	.11*	.165*	.275	.425	1.625	.....
Montreal, *delivered*	.68‡	.45†	.70	1.35	4.50†	.....
Detroit	.108	.162	.252	.486	2.205†	5.8425†
Baltimore	.117	.175	.273	.5265	1.755	3.9975
Kansas City, Mo	.15*	.21*	.335	.52	2.09†	4.35†
Philadelphia	.12	.18	.28	.54	1.80	5.2275

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

		Mar. 6	One Year Ago
New York, 45% asphalt	(at terminal)	$0.053	$0.06
New York, 65% asphalt	(at terminal)	.051	.06
New York, binder	(at terminal)	.06	.0675
New York, flux	(at terminal)	.04	.065
New York, liquid asphalt	(at terminal)	.048	.07
St. Louis, 40@50% asphalt		.05½@.05¾	.....
St. Louis, 50@60% asphalt		.05	.0548
Chicago, 40–50% asphalt		.0525	.0525
Chicago, 60–70% asphalt		.055	.055
Dallas, 45% asphalt		.0495	.04
Dallas, 55% asphalt		.0455	.048
Dallas, binder		.061	.053
San Francisco, binder, per ton		9.50*	9.50*

* F.o.b. Oelum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Mexican*)	$18@18.50	$14.50
Boston (*Mexican*)	**22.00**	**17.00**
Chicago (*Standard*)	*21.00*	*15.00*
San Francisco, *f.o.b. refinery*, Oleum, Cal.	17.00	11.00
Dallas (*Texas*)	27.10	21.10
Seattle, "*D*" *grade, California, f.o.b. Richmond*	24.75	20.50
Denver (*California*)	24.00	
Minneapolis *f.o.b. Twin Cities* (*Standard*)	*24.10*	*18.10*
St. Louis (*Trinidad*)	*32.50*	*28.50*
Baltimore (*Standard Oil*)	18.00	14.00
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	**31.50**	**28.00**
Detroit (*Mexican*)	22.00	18.00
Cincinnati (*Kentucky Rock*)	17.50	13.50
Maurer, N. J. (*Bermudez*)	28.00	26.00
Maurer, N. J. (*Mexican*)	20.50	17.50
Philadelphia (*Mexican*)	**20.00**	**17.00**
Kansas City (*Texas*)	27.30	22.30
Los Angeles "*D*" *grade, California, f.o.b. El Segundo Refinery*	17.00	11.00

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade 1)	5-in. granite, 30 blocks per sq.yd.	$135.00 per M.
Chicago	About 4x8x4 dressed	3.60 per sq.yd.
	About 4x8x4 common	*2.95* per sq.yd.
San Francisco	Basalt block 4x7x8	70.00 per M.
Boston	5-in. granite, 28 blocks per sq.yd.	**130.00** per M.
Atlanta	Granite	2.66 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4 x 8 x 4	3.25 per sq.yd.
Cincinnati	Granite	138.00 per M.
St. Louis	4x8x4 dressed	3.05 per sq.yd.
	4x8x4 common	2.90 per sq.yd.
Kansas City	Granite	3.75 per sq.yd.
Philadelphia	Granite	3.75@4.50 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.22 per sq.ft.
	Manhattan, 4 ft. wide	.22 per sq.ft.
	Queens, 5 ft. wide	.24 per sq.ft.
	6x24-in. cross-walk	1.10 per lin.ft.
Chicago	18 in. wide ... No market	... per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5 x 16 in., 85c.; 5 x 20 in., Queens, 85c. *St. Louis*: Class "A" straight, delivered, 5 x 16 in., *$1.10* per lin.ft. *Chicago*: 5 x 18 in., $3.35 per lin.ft. delivered.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York (*delivered*)	3	16	$2.29
New York (*delivered*)	3½	16	2.56
Boston	3½	18	**2.65**
Chicago	4	16	*3.20*
Chicago	3½	16	*2.90*
St. Louis	3½	16	2.65
St. Louis	4	16	3.00
Seattle	4	16	Off market
Minneapolis	3½	16	**2.75**
Atlanta	3½	16	2.00
New Orleans	3	16	2.50
New Orleans	3½	16	2.81
New Orleans	4	16	3.15
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	2.84
Detroit	4	16	3.00
Cincinnati	3½	16	2.38
Kansas City	4	16	3.00
Philadelphia	4	16	None used

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In. Mar. 6	Gravel 1½ In. One Year Ago	Gravel ¾ In. Mar. 6	Gravel ¾ In. One Year Ago	Sand Mar. 6	Sand One Year Ago
New York (*alongside dock*)	$2.00	$2.00	$2.00	$2.00	$1.25	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	2.00	2.25	2.00	2.25	2.00	2.25
St. Louis	1.40†	1.45†	*1.45*†	1.65†	1.20	1.45†
Seattle	1.50	1.00	1.50	1.00	1.50	1.00
Dallas	**2.38**	2.25	2.00	2.25	2.00	1.87½
Minneapolis	1.85*	1.75*	1.85*	1.75*	1.25-1.50	1.00
Cincinnati	1.35†	1.50†	1.35†	1.50†	1.30†	1.25†
San Francisco	2.15	2.15	2.15	2.15	1.50	1.50
Boston	1.40†	1.40	1.40†	1.40†	*1.10*†	1.10†
New Orleans	2.85	2.85	2.85	2.85	1.25	1.35
Los Angeles	2.50		2.50		1.75	
Atlanta	2.00†	1.75†	2.00†	1.75†	*1.40*†	1.24†
Detroit	1.62	2.25	1.62	2.25	2.02½	2.00
Baltimore	1.40	1.86	1.60	2.06	0.70†	0.70†
Montreal	1.25†	1.25†	1.50†	1.50†	1.25†	1.25†
Birmingham (Crushed slag used instead of gravel)					1.30†	1.25†
Philadelphia	2.15	1.75	2.15	1.80	1.65	1.70
Kansas City		1.60†		1.60†	0.66*†	0.66*

New York—Grits, $1.75 per cu. yd.; ready mixed, $2.00

Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.

* At pit.

† Per ton.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city ... otherwise, is as follows, per cu.yd.:

	1½ In. Mar. 6	1½ In. One Year Ago	2 In. Mar. 6	2 In. One Year Ago
New York	$1.75	$1.65	$1.85	...
Chicago	2.00	2.25	2.00	...
St. Louis	1.75	2.00	1.75	...
Dallas	2.83	2.00	2.83	...
San Francisco	2.15	2.15	2.15	...
Boston	**1.55***	1.85*	**1.55***	...
Minneapolis	1.85	2.00	2.00	...
Kansas City	1.50	1.50	1.50	...
Denver	3.50	3.50	3.50	...
Seattle	3.00	3.00	3.00	...
Atlanta	2.00*	2.00*	2.00*	...
Cincinnati	*1.65**	1.75*	*1.65**	...
Los Angeles *delivered*	2.75		3.00	...
Detroit	1.75	1.90@2.00*	1.75	1.90@2.00*
Baltimore	2.50	2.37	2.55	...
Montreal	1.80*	1.80*	1.90*	...
Philadelphia	2.15	1.80*	2.15	...
Pittsburgh	2.85	2.85	2.85	...
Cleveland	3.25*	3.00*	3.25*	...

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant or ...

	1½-In.	¾-In.	Roofing	Sand	Common
Youngstown District	$1.30	$1.40	$2.00	$1.30	$1.30
Steubenville District	1.40	1.40	2.00	1.40	1.40
Ironton District	1.40	1.40	2.00	1.40	1.40
Easton, Catasauqua, Pa.	0.85	0.90	2.50	...	...
Birmingham, Ala.	1.05	1.15	2.05	0.80	...
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25	...
Cleveland, Ohio	1.45	1.45	1.45	1.35	...
Eastern Pa. and Northern N. J.	1.20	1.20	2.50	1.20	...
Western Pennsylvania	1.25	1.25	2.00	1.25	...
Longdale and Glen Wilton, Va.	1.25	1.25	2.50	1.00	...
Toledo, Ohio	1.50	1.50	1.50	1.50	...

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$18.20	$13.10	$3.75*	$3.00@3.25*
Chicago	20.00	20.00	1.50†	1.50†
St. Louis	19.00	19.00	1.87½†	1.87½*
Boston	*21.00*	*15.30*	**4.30***	**3.00***
Dallas	20.00	...	...	1.85†
Cincinnati	16.80	14.30	...	13.40‡
San Francisco	22.00	...	...	2.10†
Minneapolis	25.50	21.00 (white)	1.70†	1.50†
Denver	24.00	...	...	2.70†
Detroit	20.00	19.00	18.00‡	18.00‡
Seattle, *paper sacks*	24.00	...	2.80†	...
Los Angeles	...	18.50	...	2.00†
Baltimore	24.25	17.85	2.55	...
Montreal	21.00	21.00	...	9.50‡
Atlanta	22.50	14.00	2.25†	1.65†
New Orleans	...	...	2.40†	1.85†
Philadelphia	23.00	16.00	1.93*	1.24†
Kansas City	18.40	**17.40**	**2.80***	*2.10**
Birmingham	14.50	13.75	2.00†	1.80†

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl. Minneapolis quotes brown common lump lime; Kelly Is white is $1.80 Sheboygan $1.70. New York quotes hydrated lime "on cars" in paper sacks, lump lime "alongside dealers docks" or "on cars."

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b., exclusive of bags:

	Mar. 6	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	**1.80**	1.50
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	**2.70**	2.60
St. Louis (Carney)	2.45	1.75
Birmingham (Magnolia) pozzolan cement	2.10	...

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Mar. 6	One Month Ago	One Year Ago
New York, del. by truck	$2.50@2.60	$2.50@2.60	$2.60@2.70
New York, alongside dock to dealers	2.15	2.15	2.30
Jersey City	2.33	2.33	2.48
Boston	2.63	2.63	2.75
Chicago	2.20	2.20	2.20
Pittsburgh	2.19	2.19	2.24
Cleveland	2.41	2.41	2.46
Detroit	**2.40**	2.37	2.47
Indianapolis	2.31	2.31	2.41
Milwaukee	2.35	2.35	2.37
Duluth	2.19	2.19	2.14
Peoria	2.27	2.27	2.41
Cedar Rapids	2.40	2.40	2.48
Davenport	2.29	*2.29*	2.43
St. Louis	2.20	2.20	2.35
San Francisco	2.61	2.61	2.71
New Orleans	2.40	2.40	3.30
Minneapolis	2.42	2.42	2.39
Denver	2.84	2.84	2.85
Seattle	2.90	2.90	2.90
Dallas	2.05	2.05	2.25
Atlanta	2.35	2.35	2.75
Cincinnati	2.37	2.42	2.54
Los Angeles	*3.00*	3.16	...
Baltimore	2.50	2.50	2.61
Birmingham	2.80	2.80	2.40
Kansas City	*2.10*	2.20	2.45
Montreal	**2.72**	2.25	2.15
Philadelphia	2.41	2.41	2.41
St. Paul	2.42	2.42	2.39
Toledo	2.40	...	2.48

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	**$1.95**	Hudson, N. Y.	$2.00
Universal, Pa.	1.95	Leeds, Ala.	1.95
Steelton, Minn.	2.00	Hannibal, Mo.	1.95
Fordwick, Va.	2.05	Lehigh Valley District	**2.15**
Mitchell, Ind.	1.95	Wyandotte, Mich.	2.00
Iola, Kan.	1.95	Alpena, Mich.	2.05
Mason City, Ia.	2.00	Richard City, Tenn.	2.05
La Salle, Ill.	1.95	Kingsport, Tenn.	

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago Mill	Warehouse: New York	Warehouse: St. Louis	Warehouse: Dallas	Warehouse: San Francisco
032	22	$0.95	$1.02	$1.24	$1.04	$1.12	$1.21
049	28	1.20	1.30	1.58	1.32	1.38	1.52
068	35	1.47	1.59	1.94	1.62	1.67	1.87
093	45	1.89	2.04	2.50	2.08	2.00	2.42
126	57	2.34	2.53	3.09	2.59	2.55	3.07
153	68	2.79	3.02	3.60	3.08	3.15	.....
180	78	3.20	3.47	5.22	3.54	3.47	.....
245	103	4.22	4.57	4.60	4.66	4.58	.....
287	119	4.88	5.28	6.44	5.39	5.26	6.25
336	138	5.66	6.13	7.39	6.25	6.11	.....
395	160	6.56	7.10	8.67	7.25	7.12	.....
		PAVING					
036P	17	$0.72	$0.78	$0.95	$0.79	$0.76	.....
053P	24	1.02	1.10	1.35	1.12	1.07	.....
072P	31	1.29	1.40	1.71	1.42	1.39	.....
097P	40	1.66	1.80	2.20	1.83	1.90	.....
049R	24	.....	1.10	.....	1.12	1.07	.....
067R	31	.....	1.40	.....	1.42	1.39	.....
089R	40	.....	1.80	.....	1.83	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq. ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Weight	New York	Chicago	St. Louis	San Francisco	Dallas
2.2	$22 00	$17 50	$19 50	*$19 00*	$25.50
2.5	22 00	19 50	21 00	**21 50**	27 58
2.8	22 00	21 00	23 75	.....	30 71
3.0	24 00	22 50	26 00	*23 00*	33 16
3.4	27 00	24 50	30 75	.....	35 10

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Warehouse, Uncut: Pittsburgh Mill	Birmingham Mill	New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger..	$2.40	$2.70	$3.54	$3.20	$3.35	$3.38	$3.65
⅝	2.45	2.80	3.64	3.25	3.45	3.43	3.75
¾	2.50	2.90	3.74	3.30	3.55	3.48	3.85
⅞	2.65	2.95	3.94	3.45	3.75	3.63	4.05
1	2.90	3.00	4.54	3.70	4.35	3.78	4.65

For size and cutting extras, manufacturers and distributers, see bar card of July 1, 1923.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ and larger	$2.30	$3.05	$3.08	½	$2.70	$3.30	$3.30
⅝ in	2.40	3.10	3.13	¼	3.30	3.50	3.48
¾	2.50	3.15	3.18	.....	.....	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Mar. 6	Common: One Month Ago	Common: One Year Ago	Paving Block: 3-inch*	Paving Block: 4-inch*
New York (del.).	$23.65@25.85	$23.65@25.85	$23.50	$46.50	$54.00
New York (at dock)	20@22	20@22	20.00	.....	.....
Chicago	11.00	11.00	11.00	34.00	42.00
St. Louis, salmon.	16@18	16@18	15.00	38@40	40@42.50
Denver, salmon	12.00	12.00	12.00	.....	.....
Dallas	11.60	11.60	11.00	33.00	.....
San Francisco	15.50	15.50	15.50	.....	.....
Los Angeles	14.50	14.50	.....	(not used)	
Boston (del.)	22.00	22.00	20.00	48.25	56.00
Minneapolis (del.)	16@18	16@18	17@19	.....	.....
Kansas City	16.50	16.50	14.50	(no market)	
Seattle	15.00	15.00	13.00	55.00	.....
Cincinnati	17.00	17.00	18.00	40.00	45.00
Montreal	**17.50**	16.50	16.00	100.00‡	68.00
Detroit (del.)	17.50	17.25	16.50@17.50	38.50	41.50
Baltimore (del.)	21.00	21.00	19.20	40.00	45.00
Atlanta	12.00	12.00	12.00	40.00	45.00
New Orleans	18.75	18.75	15.75	.....	.....
Birmingham	12.50@14.00	12.50@14.00	12.50	.....	.....
Philadelphia	21.00	21.00	19@25	38.00	46.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	16.00	16.00	16.00	.....	.....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. † F.o.b. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Mar. 6 on Trucks*	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12	$0.1179	$0.123	$0.064	$0.125	$0.08	$0.108	.....
6x12x12	.1769	.1844	.088	.....	.11	.156	.....
8x12x12	.2211	.2305	.12	.215	.145	.244	$0.1968
10x12x12	.....	.....	.1511	.....	.17	.....	.2442
12x12x12	.....	.....	.176	.....	.215	.....	.3175

* 5 per. off for cash.

	4x12x12	8x12x12	12x12x12
Boston	**$0.13**	**$0.24**	.....
Minneapolis (f.o.b. cars)	.07	.12	$0.20
Minneapolis (delivered)	.075	.13	.21
Cincinnati	.07485	.13745	....
Kansas City	.0965	.168	.....
Denver	.065	.123	.188
Seattle (delivered)	.11	.25	.36
Los Angeles	.0931	.1686	....
New Orleans	.12	.23	.....
Detroit (delivered)	.1044	.1958	.2737
Montreal	.115	.225	.30
Baltimore	.125	.27	.....
Atlanta	.10	.1674	.....
Dallas	.11	.20	.285
Birmingham	.11	.18	.....
Pittsburgh (delivered)	.068	.128	.179
Cleveland	.08	.164	.....

San Francisco and New York quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburgh and Birmingham, together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	Warehouse: Dallas	Warehouse: St. Louis	Warehouse: Chicago	Warehouse: San Francisco
Beams, 3 to 15 in.	$2.50	$3.00	$3.64	$4.40	$3.45	$3.30	$3.60
Channels, 3 to 15 in.	2.50	3.00	3.64	4.40	3.45	3.30	3.60
Angles, 3 to 16 in., ¼ in. thick	2.50	3.00	3.64	4.40	3.45	3.30	3.60
Tees, 3 in. and larger	2.50	3.00	3.64	4.40	3.50	3.30	3.60
Plates, ¼ in. thick and heavier	2.50	3.00	3.64	4.40	3.45	3.30	3.60

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Warehouse: Pittsburgh Mill	New York: Mar. 6	New York: One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	*$2.75*	$4.40	$3.85	$3.75	$3.90	$5.00	$4.90
CONE HEAD BOILER							
½ in	*$3.00*	$4.50	$3.95	$3.85	$4.10	$5.20	$5.00
⅝ and 11/16	*3.15*	4.66	4.11	4.00	4.35@4.70	5.35	5.19
¾ and ⅞	*3.40*	4.90	4.35	4.25	4.85	5.60	5.40

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$3.00	$3.80	$4.25	$4.55	$3.36	$4.95
Cut	3.15@3.25	4.45	5.25	5.75	3.59	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$9.20	$5.85	$7.00
⅝	7.40	5.60	5.50
¾	7.25	5.45	5.25

Pittsburgh base in lots of 200 kegs or more, $3.25@3.50.

PREPARED ROOFINGS—Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $2.71 per roll to consumers in less than carload lots f.o.b. Philadelphia.

Single shingles, red and green slate finish, cost $6.95 per square (sufficient to cover 100 sq.ft.) in less than carload lots, f.o.b. Philadelphia. Strip shingles (4 in l) f.o.b. Philadelphia, l.c.l., $6.10 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to consumers in less than carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$78.02
Tar pitch (in 400-lb. bbl.), per 100 lb	2.04
Asphalt roofing (in barrels), per ton, f.o.b. plant*	38.75
Asphalt felt (light), per ton, f.o.b. plant*	87.75
Asphalt felt (heavy), per ton, f.o.b. plant*	87.75

* Delivered in Metropolitan Dist., $2.00 additional.

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single or double strength, "AA," 84 per cent; "A," 86 per cent; "B," 88 per cent discount from jobbers' list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$3.00	$4.10	$4.00	$5.00	$4.34
No. 12	3.10	4.15	4.05	5.05	4.39
No. 14	3.20	4.20	4.10	5.10	4.44
No. 16	3.40	4.30	4.20	5.20	4.54
Black					
*Nos. 18 and 20	3.70	4.55	4.70	5.60	**4.65**
*Nos. 22 and 24	3.75	4.60	4.70	5.65	**4.70**
*No. 26	3.80	4.65	4.75	5.70	**4.75**
*No. 28	3.85	4.75	4.85	5.80	**4.85**
Galvanized					
No. 10	4.00	4.75	4.85	5.50	**4.90**
No. 12	4.10	4.85	4.95	5.60	**5.00**
No. 14	4.10	4.85	4.95	5.60	**5.00**
Nos. 17 to 21	4.40	5.15	5.25	5.90	**5.30**
Nos. 22 and 24	4.55	5.30	5.40	6.05	**5.45**
*Nos. 25 and 26	4.70	5.45	5.55	6.20	**5.55**
*No. 28	5.00	5.75	5.85	6.50	**5.85**

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Mar. 6	New York: One Year Ago	Chicago: Mar. 6	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	**$0.97**	$1.01	$0.94	$1.07

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Mar. 6	1 Yr. Ago	Mar. 6	1 Yr. Ago
Red	**15.00**	14.25	**16.50**	15.75
White	**15.00**	14.25	**15.00**	14.25

LUMBER

Prices wholesale, per M. ft. b.m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft	10-16-18 and 20 Ft.	22 and 24 Ft	25 to 32 Ft.
3x3 and 4	$35.00	$36.00	$37.00	$40.00
3x6 and 8	35.00	36.00	37.00	40.00
4x4-6 and 8	35.00	36.00	37.00	40.00
3x10 and 12	35.00	36.00	37.00	40.00
3x14	39.00	39.00	41.00	43.00
4x10 and 12	35.00	36.00	37.00	40.00
4x14	39.00	39.00	41.00	43.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$37.00	$39.00	$41.00
6x14	38.00	40.00	42.00
8x10	37.00	39.00	41.00
8x14	38.00	40.00	42.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York*		Chicago	
	20 Ft. and Under	22-24 Ft.	20 Ft. and Under	22-24 Ft.
3x4 to 8x8	**$51.00**	**$52.00**	*$48.00*	*$44.00*
3x10 to 10x10	**57.00**	**58.00**	*47.00*	*50.00*
3x12 to 12x12	**60.00**	**61.00**	*55.00*	*57.00*
3x14 to 14x14	**68.00**	**69.00**	*61.00*	*63.00*
3x16 to 16x16	**72.00**	**73.00**	*69.00*	*71.00*
3x18 to 18x18	**80.00**	**81.00**	*79.00*	*81.00*
4x20 to 20x20	.....	.....	*89.00*	*91.00*

*Wholesale price to dealers; to contractors, delivered from lighters or cars to job, $5 additional. Short leaf pine costs $3 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12 x 12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	**$58.00**	$68.00†	*$52.00*	*$52.00*	$75.00	$90.00†
Seattle	.....	29.50	.....	.....	.....	29.00
New Orleans	*28.00*	.....	.....	.....	42.00	.....
Baltimore	33.50	53.00	53.00	60.00	38.00	53.00
Cincinnati	40.00	74.00	74.00	88.00	44.00	78.00
Montreal	50.00	.....	.....	.....	.....	65.00
Los Angeles	.....	49.00	.....	.....	.....	50.00
Denver	.....	40.75	40.75	40.75	.....	41.75
Minneapolis	44.00	*43.75*	40.00	.....	47.00	44.75
Atlanta	36.00	.....	.....	.....	40.00	.....
Dallas	50.00	.....	.....	.....	54.75	.....
Kansas City	**45.75**	48.50	.....	.....	58.75	49.50
Birmingham	30@35	.....	.....	.....	40@45	.....
Philadelphia	*49.00*	42.00	43.50	48.00	60.00	43.00
Detroit	50.00	48.75	.....	.....	55.00	48.75
St. Louis	**42.00**	.....	.....	.....	54.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$48.00	*$54.00*†	*$45.00*	*$56.00*	*$62.00*†
Seattle	.....	25.00	.....	.....	29.00
New Orleans	72.00	.....	.....	*31.00*	.....
Baltimore	60.00	44.00	44.00	34.00	50.00
Cincinnati	75.00	80.00	75.00	38.00	88.00
Montreal	56.00	50.00	45.00	45.00	45.00
Los Angeles	.....	44.00	.....	.....	.....
Denver	.....	*35.75*	36.25	.....	*42.25*
Minneapolis	47.00	*39.25*	38.50	41.00	*46.25*
Atlanta	**24.00**	.....	.....	**34.00**	.....
Dallas	50.00	.....	.....	53.33	.....
Kansas City	**76.25**	46.00	.....	**73.00**	.....
Birmingham	24@28	.....	.....	32@36	.....
Philadelphia	33.00	42.00	43.00	50.00	41.00
Detroit	45.50	39.00	.....	55.00	41.00
St. Louis	43.00	.....	.....	31.50	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M.ft. to contractors.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers price to contractors on large projects.

St. Louis—Wholesale price to contractors, f.o.b. cars, $3 per M.ft. additional.

Seattle—Price to contractors, delivered.

Dallas—Wholesale to contractors, $10 per M.ft. additional.

*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
16 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

MISCELLANEOUS

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Mar. 6	One Month Ago	One Year Ago
$2.65	$2.65	$2.15@2.40

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Hercules red strand, all constructions	20%
Patent flattened strand, special steel wire rope	20%
Patent flattened strand, iron rope	5%
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington Discount: 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft.; ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; 1-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	*$0.15½@.18*	New Orleans	$0 17½
New York	.19½	Los Angeles	.20
Chicago	.18	Seattle	.18
Minneapolis	.19½	St. Louis	.16½
San Francisco	.17	Montreal	.22
Atlanta	.22½	Detroit	.20
Denver	.19½	Baltimore	.18
Cincinnati	.21	Kansas City	.19½
Dallas	.21	Birmingham	.20½
Philadelphia	.19		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.295
Boston	.23	.25
Kansas City	.22	.245
Seattle	.165	.19
Chicago	.22	.25
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.225	.302
Los Angeles	.1975	.2225
Atlanta	.23	.2550
Baltimore	.22	.23
Cincinnati	*.2125*	*.2325*
Montreal	.195	.235
Birmingham, *delivered*	.16	.17
New Orleans	.195	.22
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f. o. b. New York:

Sulphate of aluminum, in bags, per 100 lb.	$1.40@1.50
Sulphate of copper, in bbl., per 100 lb.	4.65@4.75
Soda ash, 58%, in bags, per 100 lb.	1.25@1.45
Chlorine, liquid, cylinders, 100 lb., per lb.	.08½@.09
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	*2.10*

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.31	Detroit	$0.29
Birmingham	.58	Kansas City	.735
Boston	.365	New Orleans	.67
Buffalo	.265	New York	.34
Chicago	.34	Pacific Coast (all rail)	1.15*
Cincinnati	.29	Philadelphia	.32
Cleveland	.215	St. Louis	.43
Denver	1.26	St. Paul	.60

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.